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# QUEENSLAND AGRICULTURAL JOURNAL

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## The Current Issue.

The present position in respect to banana "Bunchy Top" investigations is fully reviewed in a report to the Minister (Hon. W. N. Gillies) by the interstate committee of scientists appointed recently to inquire into the causes of the problem its occurrence has created. The banana weevil borer is also the subject of a special report by Mr. J. L. Froggatt, B.Sc. Mr. C. T. White, F.L.S., in addition to his regular feature, has some interesting notes on two weed pests—one quite new—which are causing concern to farmers in some localities. Tables and appendices supplementary to Mr. Eklund's recently concluded series on Irrigation in Queensland are included in this issue. Mr. Shelton continues his instructive articles on breeds of pigs, and adds a special illustrated note on the serious losses to the bacon industry through careless and cruel handling of pigs in the saleyards and in transit to the factory. Fruit fly investigation in the Stanthorpe district is the subject of an important report by Mr. Hubert Jarvis. Mr. Quodling's notes on the Upper Burnett will interest prospective settlers in that region. Another very useful contribution is a special note by Mr. Edmund Jarvis, accompanied by a coloured plate, on beetles affecting sugar-cane. Other seasonal features add to the value of a good April issue.

## Bacon Pig Classes at the Brisbane Show.

The pig schedule for the next Royal National Show at Brisbane in August next provides for the entry of a new class for bacon pigs of any breed. Conditions prescribe the entry of three pigs weighing, respectively, from 100 to 130 lb. None but prime quality animals will be eligible to win in this class, and they must have been fattened by and be the property of the exhibitor. Liberal prize money will be awarded successful exhibitors. This new class replaces bacon pig classes at previous shows, and it is created for the purpose of encouraging competition among bacon-pig raisers. A big entry is anticipated, for the bacon industry in Queensland is expanding rapidly and there is an ever-increasing demand from the factories for first-quality baconers.

**Science and Agriculture.**

Efficient protection must be afforded to those concerned in the producing industries, and Queensland should at once consider the necessary means of affording this protection, and the preparation of scientific workers in this field in the future. This was one of the conclusions reached by Professor Goddard, of the Queensland University, in the course of his presidential address at the first annual meeting of the Entomological Society of Queensland, at which the Acting Premier and Minister for Agriculture (Hon. W. N. Gillies) presided. In giving his reasons for this conclusion, Professor Goddard mentioned the difficulty of obtaining plant pathologists for work within the State. The Director of the Imperial Bureau of Mycology, he said, intimated, in the course of his visit to Australia last year, that it was impossible to train men for Australia, owing to the world demand, and that it was becoming more evident that we must train our own plant pathologists. The need for many plant pathologists is becoming acute. Sketching the policy of the Entomological Society, Professor Goddard pointed out that the work of the society is bound up with entomological problems of economic interest and grave national concern. Success in attempting to unravel these problems can be hastened, and even in some cases made possible, only by the co-operation of investigators, whose interests to a very large extent overlap, or are of such a nature that a mutual interchange of ideas or mutual criticism of methods is essential to progress. Mutual co-operation is thus essential to the progress of economic entomological research viewed from the national aspect. It was, he said, with this idea in view that the Entomological Society had been founded, and the doings of the past year gave good grounds for anticipating a very useful career of work. After a brief mention of some of the well-known problems just now confronting producers in the various fields of land industry, and emphasising the enormous losses involved, he went on to say that any individual who has the disposition to measure the requirements necessary for national existence in and development of the Commonwealth must recognise that it is of the greatest importance that we retain perspective on national lines (as between primary and secondary industries) and not only recognise, but assimilate and constantly apply, the fact that Queensland, in common with other States of Australia, has been adapted by Nature to be fundamentally and essentially a country of primary production. Another conclusion drawn from a noteworthy contribution to current thought is that it is absolutely necessary to provide for education in the higher branches of agriculture if Queensland is to be provided with such experts as are essential to the security and progress of her great basic industries.

**As Others See Us—Australia from a New Viewpoint.**

An excerpt from an article in the "Century" magazine (January, 1924) by Alfred Pearce Dennis, Special European Representative, United States Department of Commerce:—"One may take as a simple illustration the most primitive form of agriculture in one of the most remote and lonely spaces of the earth's surface. The Australian shepherd, who conserves hay and roots for feeding his flocks during the winter, has hardly risen from the pastoral to the agricultural stage of human culture. He would seem to represent the ultimate in economic independence and isolation. Here is a man whose trade is older than that of Ishmael, and whose habits remain substantially unaltered since the day of the Aryan dispersion. Yet the welfare of this lonely shepherd, roaming the wide spaces of earth, is intimately bound up with a circumscribed industrial region in a smallish island on the other side of the globe. When the British Government in 1919 unloaded its accumulated wool stocks on the market, the Bradford spinners quit importing, and there was not a sheep-herder on the lonely plains of New Zealand, Australia, and Argentina who did not feel the pinch of hard times." Comment would be superfluous, but it is interesting to compare this most amazing view of Australia and the lives of "her lonely shepherds, roaming the wide spaces of the earth," with the following paragraph in the "Brisbane Courier" of 12th February, 1924:—"The usefulness of the aeroplane has been demonstrated in the present floods in the Western creeks and rivers, and machines are being used in the carriage of mails and passengers over the rivers, while in some cases shearers are being conveyed to their depôts."

# INVESTIGATION OF "BUNCHY TOP" DISEASE OF BANANAS.

*Following is a report of a committee appointed as the result of an agreement between the Commonwealth, New South Wales, and Queensland Governments to investigate certain aspects of the bunchy top disease of bananas and made available by the Acting Premier and Minister for Agriculture and Stock (Hon. W. N. Gillies).*

## Terms of Appointment.

The chief relevant clause of the joint agreement is: "That a scientist representing each of the parties concerned should form an Advisory Committee to inquire fully into the investigations which have been made in the past, to advise as to the existing position, and to make recommendations to each of the three Departments concerned as to further investigations."

More explicit instructions were contained in our letters of appointment dated 5th February, in which the following paragraphs occur:—

> "In addition to reviewing the past and present position regarding bunchy top, it is desired that the committee will make recommendations as to the general lines of future research, and will suggest suitable qualifications for the necessary research officers and their assistants and the scheme of organisation necessary for the control of the work, and will indicate persons possessing those qualifications and available for the work.
>
> "It is also part of the scheme that the committee shall render its report not later than about the 1st March."

## Proceedings and Itinerary.

The committee held its first meeting at the School of Agriculture, Sydney University, on Tuesday, 19th instant, when a programme was outlined which would enable it to acquire the necessary information for this report. On the following morning, the committee had a long interview with Dr. G. P. Darnell Smith, Biologist to the Department of Agriculture, who has done much more work on the problem than anyone else, and who had already furnished us with valuable reports. In the afternoon we inspected the glass-houses recently erected in the Botanic Gardens for the use of Dr. Darnell Smith and his staff, and left for the Tweed the same evening. We arrived at Murwillumbah late on Thursday night, and spent the following day inspecting banana plantations to the south of Murwillumbah, including those of Mr. Roberts and Mr. Wells on the Soldiers' Settlement at Mullumbimby, and the promising young plantation of Mr. Lyons at North Burringbar. In the evening we had interviews with Mr. F. C. Smart, President, and Mr. F. W. Stuart, Secretary, of the Murwillumbah Fruitgrowers' Association, and Mr. P. Hunter, Director of Soldiers' Settlements in the North Coast district, who supplied us with valuable information.

On Saturday, 23rd instant, accompanied by Mr. E. A. Brown, we inspected a number of plantations in the Tweed Valley, including those of Mr. Marks and Mr. Sutton, of Terranora, and Mr. Brown, Mr. Anthony, and Mr. Tierney, of Barney's Point, on all of which a considerable amount of field experimental work on the treatment of the disease has been carried out. In the evening we gained some further useful information from Mr. Smith, Secretary of the Tweed Heads Fruitgrowers' Association, and a few local growers. The following morning, under the guidance of Mr. F. C. Smart, we visited the Bilambil Soldiers' Settlement and made a close inspection of Mr. Ormsby's plantation. In the afternoon we were joined by Messrs. Williams and Collard, of the fruit inspectors' staff of the Queensland Department of Agriculture, and proceeded to the productive plantation of Messrs, Skinner and Morley, and called in to see a young plantation on the farm of Mr. Dean of Cobaki.

Starting from Coolangatta on Monday morning, and still accompanied by Messrs. Williams and Collard, we inspected a number of plantations in the Currumbin district, including those of Mr. Allen, Mr. Freeman, and Mr. Moorhouse, which were stated to be representative of the plantations in Southern Queensland, and arrived in Brisbane the same evening.

The greater part of Tuesday was spent in interviews with Messrs. H. Tryon, J. C. Brünnich, A. H. Benson, G. Williams, H. Collard, and R. W. Peters, of the Queensland Department of Agriculture, Mr. Freeman, a large grower who had

previous experience of banana growing in Fiji, and Mr. R. G. Bartlett, who had previously been an officer of the Fruit Branch of the New South Wales Department of Agriculture in the North Coast district—all of whom afforded useful information, especially regarding the condition of affairs in Queensland, and made valuable suggestions. Late in the afternoon we motored out to the newly-infected area at Brookfield, on the north of the Brisbane River, where we saw unmistakable signs of the occurrence of the disease.

On Wednesday, we had some further interesting evidence from Mr. W. B. Christie, one of the banana industry representatives on the Fruit Marketing Committee.

### Devastating Effects of the Disease.

We thus had more than a passing glance at the ravages of bunchy top as we traversed the country from Mullumbimby, on the Brunswick, to Currumbin across the border, and heard from growers on their own plantations their experiences of this terrible scourge. All three members of the committee are agreed that we have never seen in any country more calamitous effects to a flourishing industry brought about by a plant malady. No plantation visited was free from the disease; many had been completely wiped out by it; many more were on the point of being abandoned, while even the majority of the men who had suffered least were convinced that they would be "down and out," as far as banana-growing was concerned, unless some preventive measure was forthcoming in the near future. Before the disease appeared, the beautiful valley of the Tweed and its environs must have presented a most attractive picture, with its volcanic hillsides dotted over with flourishing banana groves. To-day, in spite of the great natural scenic beauty, the feelings engendered are akin to despair as the productive lands are gradually being replaced by a weed-grown wilderness, and a thriving rural industry threatened with extinction.

### Symptoms.

The symptoms of bunchy top are very characteristic. The leaves of the affected plant are shorter and narrower than normal. They become bunched at the top of the pseudo-stem, owing to the failure of the leaf stalks to elongate. As a consequence, the expanded leaves are more erect than in a healthy plant.

The individual leaf of bunchy top plants shows, besides this dwarfing, several characteristic features, such as abnormalities in colour and texture. They are—

(1) The appearance of dark green streaks on the midrib and on the leaf stalk adjoining. These lines may vary from small spots to two inches in length. According to Dr. Darnell Smith, this is the first infallible sign of bunchy top. It is most easily seen after the white bloom, which covers a portion of the young plant, is rubbed away.

(2) Irregular, nodular lines of dark green colour that run between the main veins, particularly at the base of the leaf blade. In the normal leaf, the whole area between the main veins is faintly lined by secondary vascular strands. These lines are of even width and show no marked colour difference. In the affected plant these fine lines are frequently replaced by some two to five irregular and stouter lines which appear gorged with green colour.

(3) As the bunchy top leaf grows, it remains paler than the rich green of the normal plant, gradually assuming a more yellowish hue.

(4) The surface of the mature bunchy top leaf becomes markedly corrugated.

(5) There is a difference in the texture of the bunchy top and healthy leaf. The former is brittle and easily crushed in the hand, when it makes a characteristic crackling noise, having none of the elasticity of the normal leaf.

Such symptoms may be shown by leaves produced on suckers of any age from their first emergence from the ground to fully grown stems throwing a bunch. Cases have been observed in which bunchy top has not become apparent on a shoot until a bunch is emerging or even hanging exposed. In this case there may be no leaf symptoms, but the inflorescence shows green tips at the apices of the normally purple bracts. The fruit, where any is produced, is stunted and abnormally brittle.

Abnormal changes are to be seen in the root system. The healthy banana plant has roots of two types; (1) A spreading system of white fleshy roots, and (2) a large number of fine lateral roots borne upon these. The lateral roots are principally

concerned with absorption; they are comparatively short lived and normally die in acropetal succession. The main roots of affected plants are usually duller in colour and have purple patches upon them. They rot basipetally. The lateral roots appear unhealthy or withered and may be dead before the decay of the main roots involves them.

Dr. Darnell Smith has described various pathological changes observed on cutting open bunchy top plants. Some of these we saw, but it was not possible to make sufficient observations upon them to express an opinion as to their constancy. Such are the development of yellow to red-brown or black streaks accompanying the vascular strands which are shown on cutting across an affected corm, the less rapid development of a purple colour upon cut surfaces of the affected stem, differences in the consistency of the sap from affected and healthy plants, and so on.

It was no part of the duty of the committee to investigate the disease microscopically. This fact and the shortness of time prevented our making observations upon the many points of pathological interest that we observed. In Brisbane, however, fresh material of bunchy top and healthy leaves was obtained from Brookfield, and examined microscopically. From this examination it was abundantly clear that there is in the bunchy top plant a profound modification of the normal structure. These modifications of tissues which give rise to the first symptoms of bunchy top must have originated in the leaf during development. Hence, a plant which is said to become bunchy top rapidly—*e.g.*, on the expansion of leaves after rain—does not really do so, for leaf abnormalities must already have begun to develop before the leaf expanded. The modifications observed are not, in the ordinary sense, lesions or disease spots such as are produced by a fungus or bacterium attacking that particular area. They are rather the visible sign of abnormal developments in the leaf tissues, which interfere with the physiology of the leaf. It is clear to us that a critical microscopical comparison of the healthy and affected banana plants will be of much interest in the subsequent investigation.

## Effect of Disease upon Growth of Plant.

A plant affected by bunchy top does not necessarily die rapidly. On the other hand, we have seen may affected stools that were of considerable size and looked remarkably vigorous. If a sucker or young plant is attacked it may die, or be rooted out or choked by weeds. The stool of an older plant may persist for some seasons, throwing fresh affected shoots. In his reports, Dr. Darnell Smith, has recorded that bunchy top shoots may rot off owing to the accumulation of water in the funnel-like top caused by the obliquely ascending leaf blades. This we have frequently observed, but we have also seen quite old bunchy top stools in which such a rot is not a feature of the malady.

From bunchy-top stools there may arise shoots that appear healthy. This we have been told on more than one occasion by men on whose powers of observation we we feel we can rely. Moreover, we ourselves have seen in plantations that were abandoned because of bunchy top shoots arising from badly affected stools that appear healthy. These have developed since the recent rains. Such plantations were evidently thought sufficiently hopeful by their owners, who had neglected them for a time, to justify the resumption of cultural operations. Such cases of apparent "recovery" on the part of occasional suckers from bunchy top plants are quite possibly merely temporary, but it is not impossible that from them bunchy top-resistant strains might be obtained. Only observations over a period of time could determine this point, but we feel that they are worth making. Our evidence suggests that this was one of the methods employed in Fiji to overcome the epidemic.

## History of the Disease in Australia.

The disease was first noticed in New South Wales more than ten years ago, and appears to have spread from one centre in the Tweed area in all directions. In making this statement, which is generally borne out by the evidence of numerous planters, the mysterious nature of the disease is kept in mind and no prejudice in respect to the cause of the disease is exercised.

A certain grower, suspicious of the health and appearance of his plants, forwarded some specimens to the Agricultural Department of New South Wales for examination. Nothing in the nature of disease was detected in these specimens, and for a time the generally accepted explanation of the malformation of such plants was that it was due to some influence of a local nature. The extension and persistence of the trouble, however, eventually led this grower to refuse to supply suckers to other planters. From numerous planters who gave evidence before the committee it was gathered that it was generally believed that the disease had emanated from the

neighbourhood of this particular plantation. The disease became known first as "Cabbage Top" or "Curly Top," and later as "Bunchy Top."

During the last six years it has spread through the district, attacking plantations separated by miles from previously affected areas. Isolation gave no protection, and the rapidity of distribution and the varied and sporadic intensity of the disease baffled the planters, many of whom, on the appearance of the disease in their neighbourhood, foresaw the ultimate destruction of their entire plantation. It became quite a habit for planters to estimate at a minimum the life of a plantation once the pest had made its appearance. It seems to have early become very well established at Terranora, and to have ravaged that area in most parts with great intensity.

Despite the efforts of fruit experts, scientific experts, and the planters, the disease continued its march, until it was recognised that in New South Wales the banana industry appeared to be doomed; nothing seemed to prevent the disease from spreading to the more southern areas and repeating the ravage accomplished in the Tweed district.

An attempt to prevent the disease from extending further South was made by establishing a buffer area. Such was effected at Byron Bay, and as no plants to the north of this area were allowed to pass to the South, and a natural barrier existed in the neighbourhood in the form of a mountain range free from banana cultivation, it was hoped that by this means the distribution of the disease would be limited. Despite these precautions, the disease made its appearance in 1922 at Bangalow and in the neighbourhood of Lismore, and has been recorded from the Richmond River area during 1923.

The first record of the disease in Queensland was made about eight years ago at Currumbin. One planter, with considerable experience in banana growing in Fiji immediately prior to settling at Currumbin, informed the committee that he obtained corms from the neighbourhood of the plantation where the disease had been detected in New South Wales, the owner of this latter plantation acting in a noble spirit in refusing to dispose of plants to new planters. A very large proportion of the young plants very soon showed signs of disease, which was at once recognised by him as bunchy top, so familiar to him in Fiji. Replanting was necessary, and the plants for this purpose were obtained from another source. No sign of bunchy top was seen in these for three years.

A plantation adjoining was stocked with material from the same source in New South Wales, and of the 1,000 plants the greater number showed bunchy top. After replanting with stock from Samsonvale no bunchy top appeared until after three years.

The evidence of this planter, supported by that of other planters, seems to indicate that the first record of the disease was made from a plantation which had been stocked with affected material from a definite centre in the Tweed area.

The disease has spread through the banana-growing areas of South-Eastern Queensland in a manner comparable to that of the Tweed area of New South Wales. The seriousness of the epidemic was soon recognised by the planters. Immediately the disease was detected at Currumbin, it was suggested that the services of an Entomologist should be enlisted, and Mr. Tryon visited the Tweed (Terranora), in New South Wales, and Currumbin, in Queensland.

The disease became more and more widely distributed, and it became quite clear that the banana areas of South-Eastern Queensland were in grave danger of extinction. Early in 1920 it was suggested that experimental plots were necessary for the carrying out of manurial experiments. Visits to the area were made by the Government Fruit Culture Expert, Chemist and Plant Pathlogist during 1921, and it was recognised that the manurial experiments should be replaced by entomological and pathological investigation. Towards the end of 1922 it was reported that at Currumbin and Tallebudgera 112 plantations, representing 1,250 acres, were affected in varying degree, and it was urged that a scientific investigator should be stationed in the area. The matter of bunchy top was at that time still being investigated by Dr. Darnell Smith in New South Wales.

On 9th September, 1921, the Queensland Government issued a proclamation which prohibited the removal of any plant of the genus *Musa* (banana) excepting only the fruit thereof, from or out of any nursery, orchard, or other place in Queensland beyond an area defined as "The South Coast Fruit District."

The progress of the disease in the south-eastern areas and the impending danger to the areas north of the Brisbane River led to an agitation for the erection of a

buffer area. This was considered impracticable in view of the heavy compensation which would be involved and, further, as a strong natural buffer area had proved to be useless in New South Wales.

On 22nd December, 1923, the Government issued a proclamation rescinding that of 9th September, 1921, and proclaiming a wider area over which the restrictions embodied in the earlier proclamation would be exercised. In doing so, it was hoped that it might be possible to prevent the march of the disease north of the Brisbane River.

In February, 1924, the disease was recorded at Brookfield, north of the Brisbane River, the nearest area of infection previously recorded being distant between 40 and 50 miles. The committee visited one of the plantations at Brookfield and saw quite a number of diseased banana plants. There can be little doubt that the Brookfield records will be multiplied on systematic inspection of the plantations.

There can be little doubt in viewing the history of bunchy top in New South Wales and Queensland that the disease has been primarily distributed from a definite centre in the Tweed district. The distribution has been facilitated by the transfer of young plants and corms from this centre, there being definite proof that such a source of supply was available for the stocking of new and young plantations.

Bunchy top has been known in Fiji for more than forty years, and there can be no doubt that the Fijian disease is identical with that known to-day as bunchy top in New South Wales and Queensland. The disease still exists in Fiji, but, despite the destruction effected by it since 1885, is, according to evidence given before the committee by a planter with nearly ten years' experience in the industry in Fiji, no longer regarded as a serious menace. The prevalent idea, according to this witness, is that the disease had spent itself in those islands. In certain local areas the disease appears under suitable conditions, as on flat lands when flooded, but the suckers from such affected stools do not develop the disease in mosts cases. There can be little doubt that the disease still exists in Fiji. According to the evidence of many planters, banana stock was imported into the Tweed area from Fiji and planted at a spot where some short time later bunchy top is reported to have appeared, this being one of the earliest occurrences, and possibly the first, in Australia. This locality fits in with the central area from which the disease appears to have extended over the Tweed area, and, further, supplied much banana stock to Southern Queensland.

The evidence available thus renders it highly probable that bunchy top was imported into Australia from Fiji.

**Present Position.**

The banana industry in the affected areas is to-day in a hopeless condition, and, unless something unexpected intervenes to stay the progress of the disease, it would seem evident, in the present state of our knowledge, that there will be an extension of the region to embrace the plantations further north.

Barriers and buffer areas, in the light of experience, appear to be of no avail. Throughout the recent tour among many plantations only three were seen where the disease played, as yet, a minor part. Certainly these plantations had been well prepared before planting, were on excellent soil, had an aspect which could be regarded as ideal for banana culture, and were well cared for. Yet, in many other plantations in which everything appeared to have been done to ensure good results, the disease was rampant.

There have been numerous visits to all parts of the affected areas by scientific men and fruit experts, both in New South Wales and Queensland, and any suggestions made have been tested out by the planters, and many of these men have carried out a vast number of experiments independently.

The position to-day is that it is generally recognised that all efforts are being made in the dark. As time went on, every working theory collapsed, and now the planters recognise that they are in the hands of fate.

Experts cannot but profess ignorance in respect to the cause of the disease and cannot advise planters to follow any particular course, as the experiences of one planter, who has done all that neighbours on less affected plantations have done, indicate that we are dealing with a disease whose vagaries, in the present state of our knowledge, are inexplicable.

The position is well summed up in the statement (made by a grower whose plantation has been affected to only a minor extent) that "everything does good, but

in the end bunchy top will come out on top.'' One grower, with considerable experience in the industry in Fiji and Queensland, whose plantation has so far been affected to a minor extent, is strongly of the opinion that the disease will spend itself as in Fiji. He adopts the practice of selecting suckers from affected stools when planting, thinking that thereby a ''salting down'' of the disease would be effected. Yet, although optimistic in respect to the ultimate fate of the disease, he recognises the terrible devastation at one time brought about in Fiji, where the problem was not investigated on a scientific basis. This grower, like all others, is strongly of the opinion that the position of the industry at present is perilous, and that any help which may be of use to the industry must come from scientific investigation.

A very large proportion of the plantations has been wiped out, and in most of the others the struggle is markedly in favour of the disease. It is quite common among the majority of growers to estimate the time which will elapse before a plantation will cease to be a financial proposition.

With faint qualification in favour of those plantations where ideal conditions and culture obtain, it would appear in the present state of our knowledge that luck is on the side of those growers whose plantations are still affected to only a minor extent.

### Economic Effects of Bunchy Top

The most obvious losses caused by the disease are those sustained by individual growers, which losses have frequently been extremely serious. Many men who started growing bananas after bunchy top had made its appearance, but had not assumed the proportions of an epidemic, lost practically all the capital they had invested, although others, who had a few good years behind them, came through the financial ordeal fairly well. Apart from that, the cumulative effect of these individual losses means a great deal to the State in the shape of decreased returns in income tax, railway revenue, and many other ways. We were supplied with reliable figures illustrating this, only a few of which need be quoted.

The number of cases of bananas railed from Tweed Heads for the last three years ending 30th April has been as follows:—

| | |
|---|---|
| 1921-22 .. .. .. .. .. .. | 143,000 |
| 1922-23 .. .. .. .. .. .. | 131,000 |
| 1923-24 .. .. .. .. .. | under 50,000 |

in spite of many new plantations coming into bearing each year. Similar figures for the month of January in the last two years were—

| | |
|---|---|
| 1923 .. .. .. .. .. .. | 12,000 cases. |
| 1924 .. .. .. .. .. .. | 3,500 cases. |

The total output in the Currumbin district has dropped from 100 tons per week to 40 tons, in eighteen months.

One grower, whose books we examined, sent away from his 14-acre plantation—

| | |
|---|---|
| 1921 .. .. .. .. .. .. | 3,725 cases. |
| 1922 .. .. .. .. .. .. | 3,500 cases. |
| 1923 .. .. .. .. .. .. | 1,670 cases. |

and in another six months he expects to be down to nothing, as his plantation is over 80 per cent. ''bunchy.'' Another stated that his production had dropped from 50 cases a week to 5 within two years; while still another was producing up to 140 cases a week two years ago and to-day his production has dropped to nothing.

Well authenticated yields of over 300 cases per acre are on record, and a gross revenue of £2,000 a year from 10 acres of bananas has been obtained in one instance before bunchy top appeared. In some of these cases the productive land has now gone out of bananas or is in danger of going out with bunchy top altogether in a few years or even months. The acreage under bananas in New South Wales showed a steady increase from 2,040 in 1915-16 to 5,740 in 1920-21, but has declined to 3,800 in 1922-23 owing to the effects of bunchy top. Before the effect of the disease was felt, the average farm value per productive acre in New South Wales varied from £55 to £62 per acre—a figure which greatly exceeds that of any other crop grown extensively in New South Wales or Queensland.

There is another economic and national aspect of the question. From every point of view it is eminently desirable that the number of primary producers in Australia should be greatly increased. Banana growing, until recently, provided an excellent opportunity for successful closer settlement on small areas. It was, doubtless, this fact which induced the authorities to establish several soldier settlements in New South Wales with banana-growing as a main occupation. We visited two of these soldier settlements—one at Mullumbimby and one at Bilambil. At the former thirteen ex-service men were settled on banana blocks of about 20 acres each. To-day only six remain, and it appears certain that this number will be further reduced in the near future owing to the havoc caused by bunchy top. Indeed, it has been decided to turn the blocks into dairy farms, which will require a much larger acreage and will give a very much smaller production per acre. At the Bilambil settlement, thirty-six out of the thirty-eight original soldier settlers still remain. When it was started, it looked like developing into the best soldier settlement in Australia, and such it would doubtless have proved had not the dreaded bunchy top made its appearance. Unless some remedy is found very soon it will also have to be redesigned for dairying, for which purpose it is much less suitable. These two settlements represent only a fraction of the trouble, as there are other settlements and "single-soldier blocks" scattered all through the chief banana-growing centres. The loss to the national exchequer incurred in this way, mainly through bunchy top, promises to be quite serious.

When the banana industry was at its zenith a few years ago, very high prices were paid for suitable land, up to £150 per acre for land covered with lantana, and up to £300 for bearing plantations. Such prices were actually justified by the returns of the growers at the moment, but when bunchy top affected the crop, the whole prospect was altered, as no other crop on such land would give a return commensurate with this high capital value. At the same time, much land that was not suitable to the rather exacting requirements of the banana was planted, and this may have contributed in some measure to the reduced returns sometimes attributed to bunchy top.

It would be difficult indeed to estimate the total economic loss caused by this mysterious plant disease, but, in the opinion of growers as well as the committee, it is great enough to warrant the expenditure, on the part of the Commonwealth Government and affected States, of an even larger sum than that agreed upon at present.

## History of Investigations in Australia.

The "Agricultural Journals" of New South Wales and Queensland contain several references to bunchy top, extending over the past four years. Strictly speaking, these represent the only literature available for a student of the disease. However, we have had placed at our disposal a number of reports from various officers of the Agricultural Departments concerned. As the committee is asked to report fully, and, presumably, in an *ex parte* manner, upon the investigations that have been made in the past upon bunchy top, we feel that we should be failing in our duty were we not to say that there has been a regrettable amount of delay in investigating this serious disease in the thorough manner that it warranted. We find that various officers in the Departments concerned were fully aware of the potential danger of the trouble, at least as far back as June 1921, and asked that a man be detailed to investigate it. Apparently, this was found impracticable. Possibly, some of the difficulty arose from the fact that the outbreak began to assume epidemic proportions at the border of two States; thus delay was occasioned in concerted action. In New South Wales, Dr. Darnell Smith has devoted much time to the problem. As scientific investigators ourselves, we fully appreciate the difficulties under which he worked, but we feel that much valuable time would have been saved, and probably great financial loss averted, had he, or some other qualified person, had the time and facilities placed at his disposal for a thorough investigation of the problem in a field laboratory. A scientific investigation can only be expected to give results of permanent value if it be conducted along carefully considered lines and the investigator has at his disposal the requisite apparatus and other facilities. This we consider has not been the case, and in consequence the results obtained are disappointing and in some cases invalid. To avoid misunderstanding, we would specifically state that we attach no blame to any individual, Department, or Government. All probably have been the victims of circumstances, but the fact remains that a flourishing and remunerative industry has been brought to the verge of ruin in some areas, while the whole of the banana-growing districts of the Commonwealth are threatened. From an economic and commercial point of view, as well as from a scientific, the problem will be much more difficult to solve now than it would have been even three or four years ago.

The first published account of bunchy top in Australia known to us is in an article in the "Agricultural Gazette" of New South Wales (xxx., p. 809, 1919) on "Bunchy Top in the Tweed District." The disease was even then a very serious one in the area. In the article is a list of symptoms together with a discussion of possible causes. Bunchy top was regarded as due to root decay, with an indication that the decay might be due to drought or flood or both in sequence. The possibility that it was a result of a "running out" of the corms planted was mentioned. But in the main, bunchy top was regarded as due to faulty root development, and was stated not to be contagious. It was suggested that in some respects cultural practices along the Tweed were not in accord with the best principles, notably that the plantations were too old, and that overcrowding was encouraged by too close planting. Dr. Darnell Smith recommended that growers should take suckers from healthy plants only, and also that new strains be imported from a more tropical country.

In 1923, Dr. Darnell Smith published his second paper ("Agricultural Gazette," N.S.W., xxxiv., p. 846). In this account certain corrections and additions to his previous paper were made. Manurial trials and the importation of clean corms from the north of Queensland had shown that the disease could not be directly ascribed to either soil deficiency or to the "running out" of strains in general use. Bunchy top developed on both manured and unmanured plots and in plots planted with corms from a new source. In the interval, the suggestion that the disease was insect transmitted had come to the fore, aphis being specially suspected as transmitter. In the paper reference is made to trials of a kerosene emulsion spray, which is said to have reduced aphis attack, but not to have prevented the disease.

The committee has also had access to three reports drawn up by Dr. Darnell Smith, in one case in collaboration with Mr. H. Tryon. The first and joint report, which is summarised in the "Queensland Agricultural Journal," xix., p. 32, 1923, is the result of a conference and joint visit paid to the infected areas in the two States. As a result of their joint experiences, they state that they had not found any exclusive cause of the malady and that, moreover, explanations put forward without experimental evidence had failed to advance our knowledge of the subject. However, as a result of the New South Wales investigations, these observers stated that many of the theories put forward could be dismissed. These were that bunchy top was due to—

(*a*) Soil depletion.

(*b*) Loss of vigour on the part of the plants owing to continued planting of one strain, popularly called "running out."

(*c*) Soil acidity.

(*d*) Soil contagion, the planting of disinfected corms in soil treated with certain fungicides having failed to prevent the disease.

(*e*) Definite parasitic action. So far no parasitic organism had been isolated which could produce bunchy top under experimental conditions. This inquiry was stated to be still in progress.

(*f*) Animal parasites. Nematode worms, which had been suspected by some observers to be the cause, being not consistently present on bunchy top affected plants. Infection by aphis was then being tested.

(*g*) Harmful climatic factors in the district.

(*h*) Chemically injured soil owing to the effect of banana crops since the scrub was cleared.

The report concluded by emphasising the need for further scientific work on bunchy top in both field and laboratory. Field laboratory accommodation was considered necessary. The need for the co-operation of an Agricultural Chemist and also for the help of an Agricultural Officer who should be detailed to assist the investigation was stated.

In August, 1923, Dr. Darnell Smith presented a further report. This gives a more detailed statement of his field and laboratory experiments. Reference is made to fungus and bacterial organisms obtained from bunchy top affected plants, though the connection of these with the disease, if any, could not be established owing to lack of facilities.

Lastly, in February, 1924, Dr. Darnell Smith presented a fuller report that brings the investigation up to date. It can serve no useful purpose to summarise, in this place, the information contained therein. The report shows clearly how much

is left to be done to arrive at a proper understanding of the disease. The author advances a number of reasons that have led him to arrive at the opinion that the cause of bunchy top is to be found in the corms or roots. In order to account for the sporadic appearance of the disease, he considers that the organism, whatever it may be, has periods of active parasitism followed by others of dormancy, when it may be saprophytic. This he concludes because, when an area is newly planted, some corms may go "bunchy" in eighteen months, others only after three or four years. A considerable part of the report deals with experiments on possible insect transmission that had been conducted by Mr. Marks, of Terranora, and others under the surveillance of the Department of Agriculture. These had proved a failure, as had certain manurial trials. The latter part of the report contains reference to possible parasitic fungi and bacteria, drought effects, the possible existence of immune varieties, the question of dealing with unprofitable plantations, and the occurrence of bunchy top in other countries.

In Queensland the work accomplished has been more limited. There has been a tendency to await results from New South Wales, which is comprehensible from the point of etiquette as well as economy. Manurial trials at Currumbin in 1921 proved useless in checking the disease and were abandoned. We are, however, impressed by the serious way in which certain officers in Queensland regarded the problem, and urged the appointment of an investigator to be stationed in the field.

No account of what had been done in the way of attempted cures of bunchy top would be complete were not reference made to the considerable amount of experimentation that has been done by the growers themselves. Some of this body of men, who day by day have seen their livelihood slipping from them, have experimented widely with various manures in the belief that soil deficiency might cause the trouble. Others, actuated by the belief that a soil organism was concerned, have tried so-called remedy after remedy with the energy to be expected of desperate men. It was picturesquely stated by one of them that everything "from Epsom salts to gelignite" had been tried. After the many specifics of which we have heard, we feel that this may not be the exaggeration that it appears. Such empirical trials, of course, have no scientific value, but they do show that the men concerned realised that they were fighting an enemy in the dark—an enemy that must be overcome or they themselves would go under.

In a rather different category come certain more serious experiments such as those of Mr. E. A. Brown, of Barney's Point, Mr. Brooks, of Highfield, and Mr. Marks, of Terranora. Mr. Brown, after the trial of many manures which were without avail, believed that acidity was the cause. This he has attempted to correct, but without success. Mr. Brooks, believing that a soil organism was concerned, attempted to protect his plants, first by sulphur and later by a Stockholm tar dressing on the cut surfaces of the corm. The result has been failure. Mr. Marks believes that, whatever the case, it is insect transmitted. Noting aphis in great numbers on his plants, he devised a treatment with kerosene emulsion. He was a competitor for the £5,000 reward offered for a cure, but his specific broke down under the conditions of the test imposed. From their observations, the committee feel doubtful whether aphides play any constant part in the transmission of the disease. On the other hand, we have no hesitation in saying that a method involving any form of spraying the plants is impracticable on most of the banana plantations that we have visited.

In fine, from a study of the papers at our disposal, we are at present in ignorance of whether the disease is due to fungus or bacterium, to a virus, or to some other cause. We do not know if it be insect transmitted or whether it infects from the soil or wind. The committee feels that the bunchy top disease is one calling for a full scientific investigation, and that empirical methods do not constitute the ideal way of attacking the problem.

**Complexity of the Problem.**

It is hard to conceive any plant disease of greater scientific interest and yet of greater complexity than bunchy top. Primarily, the investigations were carried out in field and laboratory. The observations in the field suggested many theories, but each of these has had to be given up as the sole explanation of the disease, as experience increased and support failed when tested out in the field and laboratory. The usual methods of the Plant Pathologist have been applied in a laboratory, far removed from the affected areas, and have led to nothing concrete. These results are not unique, as other plant diseases have offered the same difficulties. In the present state of our knowledge it is useless to exhibit any prejudice as to the cause and nature of the disease. It is very convenient for the scientific man to crystallise

his views on the malady by regarding it as a physiological disease or virus disease, &c. Bunchy top is baffling in respect to its cause and behaviour, and, until it is investigated in as thorough a scientific fashion as the value of the industry from an economic and national standpoint warrants, it is useless to theorise. The committee realises that any ideas as to the nature of the disease which it might attempt to describe in scientific language had, in their essence, already been born in the minds of practical planters, and that all practicable means of testing out had been tried.

In the case of Panama disease, although the organisms associated with the disease have been isolated—and in this case the primary organism is in doubt—no cure has been affected. The committee in recognising the importance of the fact that in any such investigation it is essential that every attempt should be made to diagnose the cause of the disease and that this should be made the primary object in view, yet bears in mind that the real business of the committee is to elaborate a scheme by which, if possible, the means of eliminating or controlling the disease may be discovered. The problem facing a Plant Pathologist is an exceedingly difficult one, and there can be little doubt that as the investigation progresses it will be necessary for him to have the co-operation and help of workers in other branches of science.

Fortunately, the growers appreciate that the problem promises to be difficult of solution and that the investigation may be prolonged, and towards the idea of such an investigation they manifest a marked spirit of co-operation. There is only one regret on their part in connection with such a scientific investigation by means of a scientist stationed in the area, and that is a universal feeling that the delay in attacking the problem in this way has been responsible for many unnecessary financial hardships to those concerned in the industry. The scientific work already accomplished, and the experimental work carried through in both States by Government officials and growers, has led to nothing definite—a position which was made quite intelligible to the committee during the tour through the affected areas.

There is in our possession too little knowledge to enable us to pronounce any one theory as meriting a status of high probability, nor is there any justification for differentiating at this stage between possible and probable causes. Any investigation must be prepared to meet with a complex in whose being cause and effect will be confused. Consequently, we feel that any pathological investigator must have thorough support from every scientific aspect.

Knowledge of the results of the investigations into Panama disease and some other plant maladies has forced on the committee consideration of the practical value of investigations along cultural lines. Such investigations might in the end become necessary if the work of a purely pathological, physiological, and biochemical nature did not lead to a diagnosis of the cause, or succeeded in tracing the malady to some definite organism or defect but failed to find a remedy. Evidence given before the committee strongly supports the idea that every attempt should be made to institute work along such lines with a view to producing an immune strain. Such investigations might well run parallel to the scientific laboratory work. In the present state of our knowledge in respect to bunchy top, and taking into consideration the alleged history of the disease in Fiji and the experiences of other plant diseases, it would appear that investigations of this nature open up as bright a field as might be expected from the purely pathological work.

It is interesting to note that most of the suggestions made in this section of the report occurred not only to the committee as the plantations were visited, but individually were mentioned by various witnesses who appeared before the committee. This serves to indicate not only the great amount of thought which had been devoted to the malady, but the keenness of the efforts to combat this elusive disease under conditions which, in our opinion, could not be expected to lead to any definite results.

**Recommendations.**

In concluding its reports, the committee has the honour to make the following recommendations:—

(1.) It is imperative that a thorough scientific investigation of bunchy top, having as its primary object the discovery of the cause, be made by a competent scientific man of high standing. The investigator should be given a two years' engagement, subject to revision and extension, if need be, at the end of eighteen months.

(2.) The qualifications required by the investigator are a good botanical training with a special knowledge of plant pathology. The investigator, however, will meet with problems of plant physiology and genetics amongst other branches of botany. He must therefore be a man of considerable training and experience.

(3.) The locality in which the investigator should work has received careful consideration. A laboratory is needed, and it should be adjacent to a banana-growing district. There must be water and electric current available in the district. We therefore recommend that the laboratory should be at Tweed Heads or Coolangatta in a small unfurnished house, rented for the purpose. The furnishings, chiefly tables, chairs, &c., will be a small item, and could be sold at the end of the investigation.

(4.) Adjacent to the laboratory must be a small area on which pot experiments upon infected plants can be made and insect-proof enclosures erected. This need not be larger than a vacant building block.

(5.) The investigator should have under his sole control an area of about 2 acres of the best banana land available in the district. This need not be in close proximity to the laboratory though it must be within easy access. We are assured that there would be no difficulty in obtaining such land for the purposes required at a purely nominal rental.

(6.) Various pieces of apparatus will be needed, the more obvious of these being—

Microscope, objectives, camera lucida, &c.;

Incubators and autoclave;

Steam steriliser for soil;

Camera, glassware.

Others will be suggested by the investigator, but at the moment we do not anticipate any considerable addition to these. The bulk of the apparatus will be available for dispersal at the close of the investigation.

(7.) Recognising that the investigator will need to travel widely at times in the infected district, we recommend that he be provided with a motor-car, which could be sold at the end of the investigation.

(8.) We have received most encouraging offers of co-operation from the officers of the various Departments with whom we have come in contact. We recommend that full advantage be taken of these by the Bunchy Top Investigation Committee and its workers. The question of preparation of the media required for fungus and bacterial culture has been considered. This is a tedious process unless a fully equipped bacteriological laboratory is available, when it becomes a matter of routine. If the investigator be stationed at Tweed Heads or Coolangatta, we believe that media could be prepared in Brisbane, which is comparatively close. Such an arrangement seems to us preferable to having it sent from Sydney, where Dr. Darnell Smith kindly offered to have it prepared in his Department.

(9.) The services of a man will be required to undertake the cultivation of banana land and also to assist in the laboratory with such heavy work as soil sterilising, shifting of pots, &c.

(10.) At present we consider one investigator will be sufficient, but there are certain lines of work in which he will need specialist assistance. We are assured by Mr. Brünnich that soil analyses from the banana lands can be undertaken in his laboratory. It may be, however, that the investigator will need the temporary assistance of a biochemist, an entomologist, or other specialist. Such assistance we do not consider would be required for so long as the two years allowed the Investigator-in-Chief and we have budgeted for it below accordingly. It is impossible for us at the moment to foresee exactly what temporary specialist assistance may be required, but we wish to make it clear that such help will in all probability be needed from time to time. When it is asked by the investigator there should be no undue delay.

(11.) A second line of investigation, that should be undertaken at once, is on the technical or growers' side. This should have as its object the cultivation and testing of bunchy top resistant plants in an endeavour to find bunchy top free strains. From its field observations the committee believes this to be a very hopeful line of work. This second full-time worker should be a horticulturist well acquainted with banana growing. He should be at the disposal of a Bunchy Top Investigation Committee (defined below) and work in conjunction with the investigator mentioned above. Even if there should, for any reason, be a delay in the appointment of the investigator, the horticulturist should be appointed and start duties as soon as possible.

(12.) We consider that the horticulturist should tour the whole affected area and obtain plants or suckers apparently resistant to bunchy top. These should be tried out in the experiment plot referred to above.

(13.) Your committee recommends that the horticulturist should be sent at an early date to Fiji and neighbouring islands in order to obtain: (1) Information as

PLATE 50.—A QUEENSLAND BANANA PLANTATION ON VIRGIN SCRUB LAND.

to the history of the bunchy top epidemic in that country, and (2) corms of Cavendish or other suitable varieties of bananas, with a reputation for resistance to bunchy top, for trial in Australia. This tour we consider could be completed in three months.

(14.) There should be the closest co-operation between the investigator and the horticulturist. Both should be under a Bunchy Top Investigation Committee, the former being the senior officer.

(15.) For the management of the investigation we recommend the appointment of a Bunchy Top Investigation Committee, to consist of representatives of the three contracting parties. This committee, which should be ultimately responsible for the £4,500 allocated, would be the body to which the investigator and horticulturist would report and it would authorise unforeseen expenditure. We believe that the committee would not be required to meet very often, and that the investigator should be given the fullest possible amount of freedom in the carrying out of his task.

(16.) The committee has the honour to submit certain names of persons qualified for the duties mentioned above. There has been great difficulty in compiling this list, and the men suggested are at present engaged in important work which, if appointed, they will have to lay aside for a time. The qualifications of every man available in the Commonwealth have been considered. The list of possible men is very small, and it is a matter of concern to the committee that, having regard to the vital importance of agricultural pursuits in the welfare of this country, men trained to investigate the problems of plant disease are so few. We have no hesitation in saying that if the number of plant pathologists employed by various bodies in Australia could be triplicated, the expenditure would be amply repaid.

**Acknowledgments.**

Throughout the whole course of the investigation, the committee was almost overwhelmed by offers of assistance from Departmental officials, members of fruit-growing organisations, and private growers. It would be impossible to make individual acknowledgment of the services rendered by them without unduly overburdening the report, but we feel that special mention should be made of Mr. Lyons, of Upper Burringbar, and Mr. E. A. Brown, of Barney's Point, each of whom put his car and himself at the disposal of the committee for a whole day, and of the Under Secretary for Agriculture and Stock at Brisbane for giving us the use of a room and supplying us with the services of efficient typists, who worked at high pressure in order to complete the report.

ROBT. D. WATT, Chairman.
E. J. GODDARD.
J. G. B. OSBORN.

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## THE BANANA WEEVIL BORER.

Entomologist's Report.

*The Acting Premier and Minister for Agriculture and Stock (Hon. W. N. Gillies) has made available the following report by Mr. J. L. Froggatt, B.Sc., Entomologist, on his Banana Weevil Borer investigations:—*

I have the honour to submit the following reply to your communication of the 6th March, 1924, *re* my investigations into the Banana Weevil Borer problem:—

1. This research work has been in progress for three years, but the continuity thereof has received numerous interruptions, in many cases due to lack of laboratory facilities.

2. As a result of the observations, a great deal of valuable information has been obtained on the life history and habits of the pest, which has been found to have two main breeding periods during the year, covering the months of spring and autumn. During winter the beetles are comatose, and in the summer are dormant.

The beetles have shown themselves, under natural conditions, to be abhorrent of light. On account of this fact, actual observation of the movements, &c., of the weevils is virtually impossible.

The life of the beetles is a very prolonged one under natural conditions, extending over considerably more than one year. Without food, in moist soil, they can live for several months, but this appears to be governed, to a certain extent at any rate, by the time of year. This has important bearings on the problem, and requires further study.

The action of various poisons on the adult beetles has shown a marked variation as between the active and inactive periods under laboratory conditions, being much more regular in the former than in the latter. For this reason, the experimental work along this line of investigation has had to be confined to the active periods, necessitating a much longer time being taken over the tests than would otherwise have been the case. Poisoning baits with Paris green appears to offer a great simplification of the old trapping methods. Whether this poison is the most satisfactory that can be used or not cannot be decided until the whole of this work is completed.

It has been ascertained that breeding is continuous throughout the year, but the rate is much less during the inactive than during the active periods.

All old plant material lying on the ground, or left standing in the stools is needlessly helping to increase the numbers of the pest in a plantation, while it is in a healthy or semi-decaying condition. While it is in the least degree moist it also forms feeding grounds and shelter for the beetles. Cutting all this material up so that it is able to dry rapidly renders it totally unsuitable for breeding or sheltering in. The beetles are then forced into the stools, in which centres they can be more readily destroyed than when scattered broadcast throughout a plantation. This work of lessening the numbers of the beetles can never be wasted as it results in keeping the pest in check, especially when carried out in conjunction with the use of baits, preferably poisoned.

A considerable amount of work has been done on many lines of investigation without any positive result having been obtained. This has led to the expenditure of a great amount of time for no tangible profit from the growers' point of view, but such must always be anticipated in any scientific research work. The question of the flight of the beetles is one such line as would come under this category. Both laboratory and field tests which I have carried out myself, or have had carried out under my direction, have so far failed to show that the beetles fly. The statement has often been made to me that they do fly, but in only one instance, occurring early last month, has the statement been backed up by specimens. In this case the beetles were reported to have flown into the hut right alongside the plantation in the evening. What the conditions were governing this it was not possible to say.

From all my observations to date the powers of flight do not appear to be greatly exercised. This question is one which, owing to the beetle's normal abhorrence of light, is very difficult to follow. Any observations made by the banana-growers would be welcomed, particularly important being: (1) The beetles observed in flight being sent in; (2) time of day and date the flight was observed; and (3) climatic conditions.

It has been stated that any such flight "would render heaps of work done by 'tryers' more or less waste," referring presumably either: (1) To the present necessity of obtaining suckers free from the pest for planting; or (2) to the question of cleaning up the plantation.

As to (1) our knowledge of the factors governing the flight of the beetles is at present nil: it may be only exercised for a very short period of the year, and for short distances. *Re* (2) as stated previously this work can never be wasted.

Far more definite information is required before we can state to what extent the flight of the insect will affect the present practice of control.

I have briefly outlined a few outstanding results that have been obtained through my investigations into the banana weevil borer. To go fully into the matter, and show what lines of investigation had been taken up would entail considerable space, and has been dealt with in my articles in the "Queensland Agricultural Journal."

From the results obtained to date it has been found possible to formulate means of at least checking the pest if the scheme is conscientiously adhered to.

It is possible that from the work yet to be done other possible means of control may be obtained.

*Left to Right.—*

*Front Row.—*

M H Campbell,
A. M. Whittenbury,
A. S Walters (Pres.),
C. Kidd (Secretary),
H. Cutcliffe.

*Second Row.—*

R. H. Woodcock,
W C. Oxlade.
W. Hindes,
J. Harrington,
J. Beard (Government Poultry Expert).

*Back Row.—*

F. Koch.
A. E. King.
S. Lloyd.

PLATE 51.—DELEGATES TO RECENT INTERSTATE CONFERENCE OF THE NATIONAL UTILITY POULTRY BREEDERS' ASSOCIATION OF AUSTRALIA. HELD IN BRISBANE, 22ND, 23RD, JANUARY, 1924.

## REPORT ON EGG-LAYING COMPETITION, Q.A.H.S. AND C., FEBRUARY, 1924.

In the course of the month a large percentage of the birds have been in full moult, also some of the competitors have not replaced birds that died, hence the falling off in the laying for February. There were two deaths, Mrs. Hodges losing her A bird through its being struck by a hailstone, while one of Mr. Ferguson's R.I. Reds died from bowel trouble. In the light breeds Mr. N. A. Singer leads with 118 eggs, and in the heavy breeds Mr. R. Burns leads with 120 eggs. His E bird laid 28 eggs for the month, placing her over the 300-egg mark. Mr. C. H. Singer's B bird also has laid over 300 eggs. Both birds are doing well.

The following are the individual scores:—

| Competitors. | Breed. | Feb. | Total. |
|---|---|---|---|
| **LIGHT BREEDS.** | | | |
| *C. H. Singer | White Leghorns | 115 | 1,474 |
| *W. and G. W. Hindes | Do. | 116 | 1,468 |
| *N. A. Singer | Do. | 118 | 1,464 |
| *Oakleigh Poultry Farm | Do. | 87 | 1,325 |
| *Ancona Club | Anconas | 96 | 1,263 |
| *H. P. Clarke | White Leghorns | 90 | 1,248 |
| *S. L. Grenier | Do. | 97 | 1,242 |
| *R. C. J. Turner | Do. | 94 | 1,230 |
| *Beckley Poultry Farm | Do. | 84 | 1,226 |
| *Mrs. L. Andersen | Do. | 107 | 1,224 |
| *J. W. Newton | Do. | 77 | 1,214 |
| *Geo. Williams | Do. | 82 | 1,153 |
| *O. Goos | Do. | 70 | 1,151 |
| *Rock View Poultry Farm | Do. | 63 | 1,143 |
| *C. A. Goos | Do. | 76 | 1,113 |
| *Bathurst Poultry Farm | Do. | 68 | 1,105 |
| *Arch. Neil | Do. | 60 | 1,087 |
| *J. Purnell | Do. | 97 | 1,077 |
| *J. W. Short | Do. | 60 | 1,058 |
| *Mrs. R. E. Hodge | Do. | 64 | 1,055 |
| *J. M. Manson | Do. | 30 | 1,051 |
| F. Sparsholt | Do. | 37 | 1,026 |
| *H. Fraser | Do. | 66 | 1,027 |
| *A. C. G. Wenck | Do. | 52 | 1,004 |
| *N. J. Nairn | Do. | 71 | 992 |
| G. E. Rogers | Do. | 61 | 962 |
| Jas. Hutton | Do. | 33 | 950 |
| G. Marks | Do. | 40 | 942 |
| W. A. and J. Pitkeathly | Do. | 52 | 932 |
| W. and G. W. Hindes | Brown Leghorns | 72 | 929 |
| E. Ainscough | White Leghorns | 56 | 920 |
| W. Becker | Do. | 27 | 908 |
| Jas. Harrington | Do. | 45 | 903 |
| C. Quesnell | Do. | 58 | 899 |
| *Mrs. E. White | Do. | 51 | 875 |
| Parisian Poultry Farm | Do. | 40 | 853 |
| Chapman and Hall | Do. | 26 | 833 |
| Jas. Earl | Do. | 38 | 825 |
| **HEAVY BREEDS.** | | | |
| *R. Burns | Black Orpingtons | 120 | 1,386 |
| *W. Becker | Chinese Langshans | 76 | 1,284 |
| *Mrs. A. E. Gallagher | Black Orpingtons | 116 | 1,316 |
| *Jas. Potter | Do. | 76 | 1,279 |
| *Jas. Ferguson | Chinese Langshans | 92 | 1,263 |
| *Mrs. A. Kent | Black Orpingtons | 76 | 1,149 |
| *E. Walters | Do. | 75 | 1,146 |

## EGG-LAYING COMPETITION—*continued.*

| Competitors. | Breed. | Feb. | Total. |
|---|---|---|---|
| | HEAVY BREEDS—*continued.* | | |
| *T. Hindley .. .. .. .. | Black Orpingtons ... ... | 80 | 1,143 |
| *Parisian Poultry Farm .. .. | Do. ... ... | 65 | 1,128 |
| *Jas. Hutton .. .. .. .. | Do. ... ... | 56 | 1,121 |
| *E. F. Dennis .. .. .. | Do. ... ... | 80 | 1,098 |
| *C. C. Dennis .. .. .. | Do. ... ... | 76 | 1,054 |
| H. B. Stephens .. .. .. | Do. ... ... | 74 | 1,048 |
| J. R. Douglas .. .. .. | Do. ... ... | 60 | 1,047 |
| *H. M. Chaille .. .. .. | Do. ... ... | 61 | 1,045 |
| *R. Holmes .. .. .. .. | Do. ... ... | 54 | 1,037 |
| *J. H. Jones .. .. .. .. | White Wyandottes ... | 83 | 1,019 |
| W. T. Solman .. .. .. .. | Black Orpingtons ... ... | 28 | 1,015 |
| Beckley Poultry Yards .. .. | Do. .. ... | 70 | 985 |
| R. Conochie .. .. .. .. | Do. ... ... | 42 | 983 |
| W. F. Ruhl .. ... .. .. | Do. ... ... | 70 | 960 |
| G. E. Rogers .. .. .. .. | Do. ... ... | 65 | 956 |
| Rev. A. McAllister .. .. .. | Do. ... ... | 43 | 915 |
| V. J. Rye .. .. .. .. | Do. ... ... | 65 | 863 |
| Jas. Ferguson .. .. .. | Plymouth Rocks ... ... | 37 | 854 |
| F. J. Murphy .. .. .. .. | Black Orpingtons ... ... | 61 | 831 |
| W. G. Badcock .. .. .. | Chinese Langshans ... | 36 | 809 |
| Jas. Ferguson .. .. .. | Rhode Island Reds ... | 33 | 690 |
| Mos. Stephens .. .. .. | Black O pingtons ... ... | 28 | 645 |
| Totals .. .. .. | .. | 4,477 | 71,220 |

* Indicates that the pen is being single tested.

## DETAILS OF SINGLE HEN PENS.

| Competitors. | A. | B. | C. | D. | E. | F. | Total. |
|---|---|---|---|---|---|---|---|
| | | | LIGHT BREEDS. | | | | |
| C. H. Singer .. .. .. .. | 221 | 304 | 245 | 215 | 227 | 262 | 1,474 |
| W. and G. W. Hindes .. .. | 232 | 254 | 245 | 211 | 268 | 258 | 1,468 |
| N. A. Singer .. .. .. | 211 | 256 | 278 | 263 | 230 | 228 | 1,464 |
| Oakleigh Poultry Farm .. .. | 219 | 231 | 217 | 209 | 234 | 215 | 1,325 |
| Ancona Club .. ... .. | 192 | 224 | 263 | 176 | 186 | 222 | 1,263 |
| H. P. Clarke .. .. .. | 230 | 164 | 228 | 188 | 220 | 218 | 1,248 |
| S. L. Grenier .. .. .. | 178 | 216 | 240 | 204 | 203 | 201 | 1,242 |
| R. C. J. Turner .. .. .. | 196 | 208 | 203 | 200 | 192 | 231 | 1,230 |
| Beckley Poultry Farm .. .. | 204 | 191 | 185 | 218 | 212 | 216 | 1,226 |
| Mrs. L. Andersen .. .. .. | 180 | 212 | 226 | 217 | 204 | 185 | 1,224 |
| J. W. Newton .. .. .. | 222 | 208 | 198 | 169 | 205 | 212 | 1,214 |
| Geo. Williams .. .. .. .. | 216 | 221 | 180 | 180 | 180 | 176 | 1,153 |
| O. Goos .. .. .. .. | 175 | 203 | 207 | 188 | 180 | 198 | 1,151 |
| Rock View Poultry Farm .. .. | 211 | 227 | 211 | 190 | 160 | 144 | 1,143 |
| C. A. Goos .. .. .. .. | 189 | 202 | 143 | 199 | 181 | 199 | 1,113 |
| Bathurst Poultry Farm .. .. | 193 | 196 | 149 | 210 | 178 | 179 | 1,105 |
| Arch. Neil .. .. .. .. | 159 | 195 | 166 | 197 | 197 | 173 | 1,087 |
| J. Purnell .. .. .. .. | 185 | 185 | 168 | 178 | 192 | 169 | 1,077 |
| J. W. Short .. .. .. .. | 195 | 165 | 183 | 154 | 202 | 159 | 1,058 |
| Mrs. R. E. Hodge .. .. .. | 153 | 180 | 178 | 190 | 192 | 162 | 1,055 |
| J. M. Manson .. .. .. | 152 | 154 | 180 | 215 | 180 | 170 | 1,051 |
| H. Fraser .. .. .. .. | 174 | 155 | 170 | 179 | 187 | 160 | 1,025 |
| A. C. G. Wenck .. .. .. | 179 | 169 | 134 | 178 | 150 | 194 | 1,004 |
| N. J. Nairn .. .. .. .. | 176 | 150 | 184 | 166 | 150 | 166 | 992 |
| Mrs. E. White .. .. .. | 101 | 156 | 182 | 178 | 158 | 100 | 875 |

EGG-LAYING COMPETITION—*continued.*

DETAILS OF SINGLE HEN PENS—*continued.*

| Competitors. | A. | B. | C. | D. | E. | F. | Total. |
|---|---|---|---|---|---|---|---|
| HEAVY BREEDS. | | | | | | | |
| R. Burns .. .. .. .. | 236 | 246 | 208 | 189 | 314 | 193 | 1,386 |
| Mrs. A. E. Gallagher .. .. | 209 | 230 | 222 | 223 | 216 | 216 | 1,316 |
| W. Becker .. .. .. .. | 219 | 219 | 229 | 223 | 202 | 192 | 1,284 |
| Jas. Potter .. .. .. .. | 194 | 240 | 206 | 203 | 207 | 229 | 1,279 |
| Jas. Ferguson .. .. .. | 225 | 234 | 207 | 197 | 186 | 214 | 1,263 |
| Mrs. A. Kent .. .. .. .. | 169 | 220 | 156 | 243 | 179 | 182 | 1,149 |
| E. Walters .. .. .. .. | 227 | 227 | 175 | 154 | 180 | 183 | 1,146 |
| T. Hindley .. .. .. .. | 194 | 202 | 205 | 197 | 180 | 165 | 1,143 |
| Parisian Poultry Farm .. .. | 172 | 187 | 183 | 213 | 187 | 186 | 1,128 |
| Jas. Hutton .. .. .. | 213 | 166 | 195 | 198 | 158 | 191 | 1,121 |
| E. F. Dennis .. .. .. | 190 | 202 | 188 | 187 | 143 | 188 | 1,098 |
| C. C. Dennis.. .. .. .. | 186 | 200 | 186 | 178 | 182 | 174 | 1,056 |
| H. M. Chaille .. .. .. | 164 | 197 | 190 | 169 | 155 | 170 | 1,045 |
| R. Holmes .. .. .. .. | 134 | 153 | 168 | 178 | 197 | 207 | 1,037 |
| J. H. Jones .. .. .. ... | 190 | 187 | 172 | 140 | 145 | 185 | 1,019 |

J. K. MURRAY, Principal.

## N.U.P.B.A. COMPETITION, ZILLMERE.

RESULTS FOR FEBRUARY.

With only one more month to go this competition has reached an interesting stage. For first place a White Leghorn and Black Orpington tied, while in both sections there were several birds with only an egg or two difference. A close finish is almost certain. One thousand nine hundred and twenty-six eggs were laid during the month, an average of 14¾ per bird. The following birds are moulting:—22, 31, 35, 68, 74, and broodiness has affected the laying of the following birds during February:—25, 45, 54, 84, 85, 95, 100, 103, 104, 106, 110, 111, 115, 116, 118.

WHITE LEGHORNS.

| Pen No. | Owner. | Feb. | Total. | Pen No. | Owner. | Feb. | Total. |
|---|---|---|---|---|---|---|---|
| 62 | Miss L. M. Dingle .. | 23 | u281 | 71 | W. H. Forsyth .. | 19 | 230 |
| 14 | Enroh Pens .. .. | 24 | u273 | 49 | J. Harrington .. | 17 | 229 |
| 4 | T. H. Craig .. .. | 23 | 249 | 10 | R. C. J. Turner .. | 21 | u228 |
| 72 | W. H. Forsyth .. | 21 | 248 | 78 | W. Smith .. .. | 23 | 228 |
| 75 | W. Shaffrey .. | 20 | u247 | 2 | Carinya P.F. .. | 23 | 226 |
| 28 | H. T. Britten .. | 22 | 246 | 3 | T. H. Craig .. .. | 23 | 224 |
| 27 | H. T. Britten .. | 20 | u245 | 22 | M. F. Newberry .. | 6 | 224 |
| 51 | Kidd Bros. .. .. | 22 | 244 | 37 | G. Williams .. .. | 20 | 220 |
| 50 | J. Harrington .. | 19 | 243 | 18 | A. W. Ward .. .. | 13 | 218 |
| 13 | Enroh Pens .. .. | 21 | 241 | 38 | G. Williams .. .. | 20 | 218 |
| 20 | W. Witt .. .. | 21 | 241 | 42 | W. Wakefield .. | 16 | 217 |
| 53 | H. Holmes .. .. | 25 | u240 | 54 | H. Holmes .. .. | 13 | u216 |
| 59 | G. Scaletti .. .. | 23 | 240 | 21 | M. F. Newberry .. | 22 | 216 |
| 16 | W. J. Berry .. .. | 21 | u238 | 69 | R. Shaw .. .. | 11 | 215 |
| 41 | W. Wakefield .. | 21 | 238 | 48 | R. D. Chapman .. | 22 | 214 |
| 7 | Oakleigh P.F .. .. | 14 | 235 | 61 | Miss L. M. Dingle .. | 15 | 213 |
| 43 | Kelvin P.F. .. .. | 20 | 235 | 70 | R. Shaw .. .. | 15 | 213 |
| 66 | R. Duff .. .. | 12 | 234 | 83 | L. Andersen .. .. | 21 | 213 |
| 73 | A. Hodge .. .. | 21 | 233 | 26 | E. Stephenson .. | 19 | 212 |
| 8 | Oakleigh P.F. .. | 21 | 231 | 34 | A. S. Walters .. | 19 | u209 |
| 58 | H. Fraser .. .. | 27 | u231 | 40 | J. Earl .. .. | 18 | 209 |
| 15 | W. J. Berry .. | 7 | u230 | 55 | G. Baxter .. .. | 17 | 209 |
| 30 | W. and G. W. Hindes | 18 | 230 | 45 | F. R. Koch .. .. | 20 | 207 |
| 33 | A. S. Walters .. | 14 | 230 | 84 | L. Andersen .. | 3 | 207 |

"u" indicates eggs under 2 oz.

## N.U.P.B.A. COMPETITION, ZILLMERE—*continued.*

### White Leghorns—*continued.*

| Pen No. | Owner. | Feb. | Total. | Pen No. | Owner. | Feb. | Total. |
|---|---|---|---|---|---|---|---|
| 36 | J. T. Webster .. .. | 15 | 206 | 57 | H. Fraser .. .. | 11 | 177 |
| 77 | W. Smith .. .. | 19 | 205 | 63 | S. Lloyd .. .. | 8 | u176 |
| 74 | A. Hodge .. .. | 4 | 205 | 56 | G. Baxter .. .. | 12 | 172 |
| 44 | Kelvin P.F. .. .. | 20 | 204 | 25 | E. Stephenson .. | 10 | u170 |
| 11 | A. Neil .. .. | 19 | 201 | 35 | J. T. Webster .. | 2 | 169 |
| 47 | K. D. Chapman .. | 21 | 199 | 9 | R. S. J. Turner .. | 21 | u167 |
| 52 | Kidd Bros. .. .. | 20 | 199 | 17 | A. W. Ward .. .. | 11 | 165 |
| 76 | W. Shaffrey .. .. | 12 | 199 | 46 | F. R. Koch .. .. | 15 | 165 |
| 12 | A. Neil .. .. | 16 | u197 | 19 | W. Witt .. .. | 9 | 164 |
| 23 | Parisian P.Y. .. | 11 | 197 | 31 | H. Needs .. .. | 5 | 164 |
| 32 | H. Needs .. .. | 19 | 195 | 85 | A. Cowley .. .. | 1 | 154 |
| 5 | P. J. Fallon .. .. | 20 | 193 | 82 | J. E. G. Purnell .. | 9 | 149 |
| 81 | J. E. G. Purnell .. | 9 | 193 | 67 | J. and G. Green .. | 8 | 145 |
| 39 | J. Earl .. .. | 18 | 192 | 68 | J. and G. Green .. | 0 | 115 |
| 64 | S. Lloyd .. .. | 0 | 190 | 60 | G. Scaletti .. .. | 16 | 113 |
| 6 | P. J. Fallon .. .. | 10 | 186 | 65 | R. Duff (replaced 6th October, 1923) .. | 17 | 101 |
| 1 | Carinya P.F. .. .. | 5 | 185 | 80 | W. Bliss .. .. | 5 | 69 |
| 29 | W. and G. W. Hindes | 1 | u185 | 86 | A. Cowley .. .. | 0 | 38 |
| 24 | Parisian P.Y... .. | 20 | 179 | | | | |
| 79 | W. Bliss .. .. | 20 | 179 | | | | |

### Black Orpingtons.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 101 | Enroh Pens .. .. | 21 | 249 | 105 | W. Smith .. .. | 9 | 196 |
| 92 | J. Pryde .. .. | 13 | u248 | 120 | J. Harrington .. | 7 | 186 |
| 109 | T. H. Brotherton .. | 22 | 245 | 108 | E. F. Dennis.. .. | 13 | 184 |
| 117 | E. C. Raymond .. | 21 | 241 | 98 | W. Shaffrey .. .. | 19 | 180 |
| 95 | J. Potter .. .. | 2 | 235 | 116 | C. C. Dennis .. | 13 | 179 |
| 89 | K. Macfarlane .. | 23 | 230 | 102 | Enroh Pens .. .. | 7 | 170 |
| 93 | H. B. Stephens .. | 24 | u221 | 104 | L. Pritchard .. | 7 | 170 |
| 113 | E. Walters .. .. | 23 | 220 | 99 | S. Donovan .. | 18 | 167 |
| 96 | J. Potter .. .. | 16 | 215 | 94 | H. S. Stephens .. | 13 | 161 |
| 115 | C. C. Dennis.. .. | 13 | u215 | 119 | J. Harrington .. | 0 | 146 |
| 118 | E. C. Raymond .. | 15 | 212 | 103 | L. Pritchard .. | 10 | 144 |
| 112 | H. M. Chaille .. | 14 | 201 | 114 | E. Walters .. .. | 16 | u141 |
| 110 | T. H. Brotherton .. | 0 | 200 | 97 | W. Shaffrey .. .. | 13 | 136 |
| 90 | K. Macfarlane .. | 14 | 199 | 107 | E. F. Dennis .. | 5 | 113 |
| 87 | Parisian P.Y. .. | 19 | 198 | 100 | S. Donovan .. .. | 4 | 94 |
| 91 | J. Pryde .. .. | 19 | u198 | | | | |

### Other Varieties.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 131 | W. H. Forsyth (S.W.) | 17 | 236 | 127 | A. S. Walters (B.R.) | 8 | 155 |
| 125 | J. Ferguson (Lang.) | 18 | 219 | 128 | A. S. Walters (B.R.) | 1 | 155 |
| 126 | J. Ferguson (Lang.) | 13 | 183 | 129 | R. A. Girling (Min.) | 18 | 147 |
| 123 | J. Ferguson (Anc.) | 18 | 161 | 132 | W. H. Forsyth (S.W.) | 2 | u131 |
| 122 | Parisian P.Y. (B.L.) | 13 | 158 | 124 | J. Ferguson (Anc.) | 2 | 126 |
| 130 | R. A. Girling (Min.) | 18 | 156 | 121 | Parisian P.Y. (B.L.) | 10 | u121 |

"u" indicates eggs under 2 oz.

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## QUEENSLAND TREES.

No. 29.

By C. T. WHITE, F.L.S., Government Botanist, and W. D. FRANCIS, Assistant Botanist.

The Sour Cherry, *Eugenia corynantha*, is a fairly large tree of the Southern Queensland rain forests. It attains a height of about 110 feet and a barrel diameter of about 2 feet. The bark is grey and in larger trees generally scaly. The wood often splits well and has been used by settlers in constructing the rough buildings which are used in the early stages of land clearing and other initial work. The fruit is deep red in colour, very fleshy, and acid to the taste. They ripen in large numbers and are seen thickly strewn on the ground beneath the trees. They provide food for pigeons and other birds. The species has also been known under the botanical name of Eugenia punctulata, but the one we have used at the beginning of this article is the older name and therefore the valid one. The trees are found as far south as Port Macquarie, New South Wales (F. V. Mueller), and as far north as Gympie.

*Photo. by Authors.*] PLATE 52.—THE SOUR CHERRY.

*Eugenia corynantha* on left, the tree on the right hand side of the picture is *Endiandra discolor*. The photo. was taken at Cedar Creek, westward of Eumundi.

*Photo: Dept. Agriculture and Stock.*

PLATE 53.—THE SOUR CHERRY.

A. Dried herbarium specimen of branchlet bearing flowers, natural size.

B. Fresh branchlet bearing fruit, to scale.

# WEEDS OF QUEENSLAND.

By C. T. WHITE, Government Botanist.

No. 36.

## BLUE TOP HELIOTROPE (*HELIOTROPIUM ANCHUSAEFOLIUM*).

*Description.*—A widely spreading more or less procumbent perennial with ascending stems, clothed in all parts with rather long but scattered hairs. Leaves soft with wavy edges, oblong-lanceolate, mostly about 1½ inches long, and about ¼-inch broad. Flowers lilac or blue, with a yellow tube and throat, arranged in forked one-sided spikes, the spikes recurved at the top, from a few lines to 3 inches or even longer, according to age. Fruit consisting of two carpels (seeds),* each carpel or "seed" more or less flattened on the inner side, the outer side rounded, slightly rugose; about 1½ lines long and nearly as broad.

*Distribution.*—A native of Brazil and the Argentine, South America. In Australia it is a common weed in South-eastern Queensland, and also occurs as a naturalised alien in South Australia (Black, "Naturalised Flora of South Australia.")

*Common Names.*—Blue Top, Blue Weed, and Wild Heliotrope are names in common use for it in Queensland.

*Botanical Name.*—*Heliotropium*, from the Greek *helios* the sun, and *trepo* I turn; from the belief that the flowers always turned towards the sun.

*Properties.*—It is not known to possess any poisonous properties, and I do not know it to have any economic value.

*Eradication.*—The plant was no doubt introduced as a garden plant and was naturalised on the coastal lands for many years past, but has never given evidence there of being of an aggressive nature. A few years ago it made its appearance on the Darling Downs and a few other places, and has established itself as a very bad weed, most difficult of eradication and rapidly on the increase. The plant is a perennial and makes a long, strong, slender tap root.

In small areas such as gardens and household allotments forking or pulling out of the plant so that the central root is destroyed is the best means of eradication. In larger areas the plants should be hoed off, care being taken to see that the central root is cut well below the surface of the ground.

Where it can be used in safety an arsenical spray might be tried, and as a spray suitable for weed destruction the Agricultural Chemist (Mr. J. C. Brünnich) has recommended the following:—

"Half a pound of arsenic dissolved by means of one-quarter of a pound of caustic soda in three gallons of water, and the solution then diluted to ten gallons with water."

As the plant is a comparatively recent introduction on the Downs and it already shows the power of becoming a bad pest, a lookout should be kept for it and the plants destroyed when they put in an appearance. It can be easily recognised by its blue flowers and typical heliotrope appearance.

*Botanical Reference.*—*Heliotropium anchusaefolium*, Poiret Suppl. III. 23.

* What is popularly known as the seed in this plant is really a carpel containing two or sometimes one seed.

Plate 54.—Blue Top Heliotrope (*Heliotropium anchusaefolium*).

# NOTES ON TWO WEED PESTS.

By C. T. WHITE, Government Botanist.

## A NEW WEED AND A WARNING.

Under date 18th February, 1924, Mr. Quigley, of Deuchar, near Warwick, S. W. Railway, writes:—

"There is a creeping plant growing on my property at Deuchar which is giving me quite a lot of trouble in trying to destroy, but without success. It is only a small plot in the centre of a cultivation paddock, about one chain square, and I have ploughed it fully a foot deep with a disc plough, but it makes a fresh growth below where it is cut off. It has been here to my knowledge thirteen years, and strange to say the plot has not got any larger, although it surely must have seeded at some time.

"I am forwarding you a specimen of the plant under separate cover and would ask you to be good enough to let me know the name of the plant, and the best means of destroying same. I might also add I have been on the lookout for years, but have failed to find it growing on any other place. Should you require any further information I will be only too pleased to let you have it.

"Trusting you will oblige."

The weed forwarded by Mr. Quigley is the common Bindweed (*Convolvulus arvensis*), a native of Europe but widely distributed over the temperate regions of the globe. It has not been previously recorded for Queensland, but is a particularly troublesome pest in cultivation areas and very abundant in the Southern States—particularly Victoria—where it causes a lot of trouble by its twining stems curling round the stalks of cultivated plants and practically choking them. It is a perennial with extensive underground creeping stems, often a foot below the surface of the soil and any small part of which is capable of forming a new plant. Small plots can be grubbed out and the underground stems and roots picked out and burnt. Means of spreading is principally by seed. Fortunately, Mr. Quigley's statement that the weed has been on his property for thirteen years without signs of spreading would indicate that the Queensland climate does not suit the plant too well, and possibly this prevents ripe seeds being formed. The plant can be told by its pink (sometimes almost white) small convolvulus flowers and its creeping underground stems.

## THE RUBBER VINE.

Writing in the "Peak Downs Telegram," Clermont, of 26th January, under the heading of "A Warning," a correspondent ("Experior") writes:—

"I wish to draw your attention to a certain vine, the rubber plant, which has been declared a noxious weed. This plant contains caustic, which, when the plant is dead, takes the form of powder. This is dangerous, and when the dead vine is broken the powder emerges like a fine dust. This enters the throat, causing violent coughing. A swelling begins each side of the nose, and the eyelids come up in blisters. This powder does not affect all people. The best remedy is to stop the coughing, and apply hot foments to eyes and nose. The plant when green oozes a white sap. I trust this will serve as a useful warning."

The plant referred to is evidently the Rubber Vine (*Cryptostegia grandiflora*), an illustrated article on which appeared in this Journal for April, 1923. It has been declared a weed for the whole State, but as such is restricted to the Central and Northern parts of the State.

I have not previously heard of the plant as an irritant, and would be glad to hear of the experiences of any other people in respect to the plant in this direction. A feature noted by "Experior"—namely, that all people are not affected—is a characteristic of most skin-irritating plants. The vine is a native of Madagascar, but is widely distributed as a cultivated plant over the warmer regions of the globe.

## MILKING RECORDS, Q.A.H.S. AND COLLEGE DAIRY HERD, FEBRUARY, 1924.

| Name of Cow. | Breed. | Date of Calving. | Total Milk. | Test. | Commercial Butter. | Remarks. |
|---|---|---|---|---|---|---|
| | | | Lb. | % | Lb. | |
| College Cobalt .. | Jersey .. | 14 Sept., 1923 | 840 | 4·6 | 45·30 | |
| College Wildflower | ,, | 13 Aug., 1923 | 660 | 5·0 | 39·00 | |
| Netherton Belle | Ayrshire | 30 Oct., 1923 | 870 | 3·7 | 37·50 | |
| Dawn of Warragaburra | Jersey .. | 10 Nov., 1923 | 690 | 4·5 | 35·60 | |
| College Grandeur | ,, | 11 July, 1923 | 540 | 5·7 | 36·30 | |
| College Sunrise.. | ,, | 3 Jan., 1924 | 780 | 3·8 | 34·80 | |
| Comedienne .. | ,, | 10 July, 1923 | 510 | 5·7 | 34·20 | |
| Hedges Nattie .. | Friesian | 21 Nov., 1923 | 720 | 2·8 | 32·10 | |
| Miss Fearless .. | Ayrshire | 17 Nov., 1923 | 720 | 3·8 | 32·10 | |
| Bellona .. .. | ,, | 3 Aug., 1923 | 690 | 3·9 | 31·20 | |
| Magnet's Leda .. | Jersey .. | 18 Aug., 1923 | 630 | 4·2 | 30·90 | |
| Miss Security .. | Ayrshire | 8 June, 1923 | 800 | 3·3 | 30·80 | |
| Hedges Madge .. | Friesian | 18 Aug., 1923 | 720 | 3·6 | 30·00 | |
| College Promise | Jersey .. | 14 Aug., 1923 | 570 | 4·4 | 29·40 | |
| Miss Betty .. | ,, | 30 Oct., 1923 | 630 | 4·0 | 29·40 | |
| Fair Lassie .. | Ayrshire | 28 Nov., 1923 | 630 | 3·8 | 28·20 | |
| Songstress .. | ,, | 22 Aug., 1923 | 600 | 4·0 | 27·90 | |
| Buttercup .. | Shorthorn | 7 Sept., 1923 | 750 | 3·2 | 27·90 | |
| Dear Lassie .. | Ayrshire | 1 Nov., 1923 | 660 | 3·9 | 27·30 | |
| College Hope .. | Jersey .. | 21 Oct., 1923 | 480 | 4·8 | 27·00 | |
| College Meadow Queen | Friesian | 10 Jan., 1924 | 720 | 3·2 | 26·70 | |
| Guid Lassie .. | Ayrshire | — Jan., 1924 | 600 | 3·8 | 26·70 | |
| Yarraview Snowdrop | Guernsey | 7 Sept., 1923 | 480 | 4·7 | 26·40 | |
| College Ma Petite | Jersey .. | 12 June, 1923 | 510 | 4·4 | 26·10 | |
| College Desire .. | Ayrshire | 11 July, 1923 | 480 | 4·2 | 23·70 | |
| Confidante .. | ,, | 7 Sept., 1923 | 600 | 3·4 | 23·70 | |
| College St. Martha | Jersey .. | 25 June, 1923 | 390 | 5·0 | 22·80 | |
| Mistress May .. | Ayrshire | 20 June, 1923 | 480 | 4·0 | 22·20 | |
| Lady Meg .. | ,, .. | 14 July, 1923 | 600 | 3·8 | 21·70 | |
| College La Cigale | Jersey .. | 25 June, 1923 | 360 | 5·1 | 21·60 | |
| Gay Lassie .. | Ayrshire | 5 July, 1923 | 420 | 4·2 | 20·70 | |
| Miss Faithful .. | ,, | — Jan., 1924 | 450 | 3·8 | 20·10 | |

## NATURAL METHOD OF INSECT CONTROL.

Some time since the Entomologist stationed at Stanthorpe, Mr. H. Jarvis, introduced into the Stanthorpe area an hymenopterous parasite of the notorious fruit fly—a Braconid named *Opius tryoni*, Cameron, in honour of its discoverer—and the plan of campaign there embraces a full exploitation of this method of natural control by the aid of supplementary enemies, yielded by other hymenopteræ known to us.

In addition to the fruit fly, *Chætodacus tryoni*, there are other redoubtable insect pests occurring in the district, notably the Woolly Aphis of the apple, *Schizoneura lanigera*.

In order to cope with this, by the natural method of control also, a small chalcidid wasp named *Aphelinus mali*, a formidable enemy to this so-called American blight insect, was introduced into the Granite Belt area in September, 1923.

This was mentioned by Mr. Jarvis in his latest periodical report—December, 1923—January, 1924, inclusive—wherein he writes as follows:—

"The Woolly Aphis parasite, *Aphelinus mali*, Hald., imported from New Zealand 14th August, 1923, by courtesy of Dr. R. J. Tillyard, M.A., D.Sc., &c., will, I hope, become established in this district. One hundred and seven examples of this parasite were bred from the material sent me by Dr. Tillyard. These were liberated in three

trees infested with Woolly Aphis; the last date on which parasites were liberated was on 28th September, 1923. From time to time the trees on which parasites had been liberated were examined, but nothing was seen of them until 20th January, 1924. On that date a large number of Woolly Aphis were discovered showing the characteristic hole made by the parasite in emerging.

"Very many of these parasites must then have already hatched out and dispersed about the orchards in the Stanthorpe area, in which the majority of the first brood were liberated.

"On carefully examining the apple trees in this orchard little or no Woolly Aphis was visible, so that my only fear is that the parasite may not (from lack of its host) continue to multiply.

"Only one individual *Aphelinus* was recovered from twigs (bearing a few Aphids) taken from the tree on which they were first liberated and kept under conditions to admit of the obtainment of any specimens on issuing. Additional specimens will, I hope, hatch out in order to provide sufficient material to carry over the winter for use in distribution next spring.

"Application has been made to Dr. Tillyard for an additional supply of the parasite to ensure its successful establishment in this district as a permanent useful endowment." (H. Jarvis' Report, December, 1923—January, 1924.)

The question of the permanent establishment of this useful insect (*Aphelinus mali*) in the Stanthorpe district as a powerful control of the apple pest referred to, being thus still an open one, the Assistant Entomologist, Mr. A. A. Girault (one of the foremost authorities on chalcidid insects in the world, as indicated by his voluminous writings on the subject), who happened to be sojourning in Stanthorpe on private business, was instructed to pursue investigations there, that it might be finally settled.

And already he reports that this useful insect is still living at large near where liberated. "Instructions," he writes, "were carried out at Stanthorpe on 18th March; the parasite was located alive in two places in the original orchard," where its establishment, as a basis for further distribution, had been effected."

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## FORTHCOMING SHOWS.

The Queensland Chamber of Agricultural Societies has supplied the following list of show dates for 1924:—

Wallumbilla: 15th and 16th April.
Clifton: 16th and 17th April.
Herberton, 21st and 22nd April.
Oakey: 24th April.
Maleny: 23rd and 24th April.
Goondiwindi: 29th and 30th April.
Blackall: 6th and 7th May.
Charleville: 6th and 7th May.
Taroom: 6th and 7th May.
Toogoolawah: 7th and 8th May.
Wondai: 8th and 9th May.
Boonah: 14th and 15th May.
Springsure: 14th and 15th May.
Murgon: 15th and 16th May.
Roma: 20th and 21st May.
Kilkivan: 21st and 22nd May.
Ipswich: 21st to 23rd May.
Emerald: 21st and 22nd May.
Beaudesert: 28th and 29th May.
Gayndah: 28th to 31st May.
Marburg: 2nd and 3rd June.
Hughenden: 3rd and 4th June.
Esk: 4th and 5th June.
Maryborough: 3rd to 6th June.
Childers: 10th and 11th June.
Bundaberg: 12th to 14th June.
Pine Rivers: 13th and 14th June.
Gin Gin: 16th and 18th June.
Woombye: 18th and 19th June.
Gladstone: 19th and 20th June.
Lowood: 20th and 21st June.
Mount Larcom: 21st June.
Rockhampton: 24th, 26th, 27th, and 28th June.
Mackay: 3rd to 5th July.
Kilcoy: 3rd and 4th July.
Biggenden: 3rd and 4th July.
Wallumbilla: 8th and 9th July.
Bowen: 9th and 10th July.
Laidley: 9th and 10th July.
Woodford: 10th and 11th July.
Gatton: 16th and 17th July.
Townsville: 16th and 17th July.
Caboolture: 17th and 18th July.
Sunnybank: 19th July.
Barcaldine: 22nd and 23rd July.
Charters Towers: 23rd and 24th July.
Rosewood: 23rd and 24th July.
Ithaca: 25th and 26th July.
Nambour: 30th and 31st July.
Ayr: 1st and 2nd August.
Mount Gravatt: 2nd August.
Humpybong: 7th August.
Royal National: 11th to 16th August.
Gympie: 20th and 21st August.
Belmont: 23rd August.
Imbil: 27th and 28th August.
Coorparoo: 30th August.
Crow's Nest: 4th September.
Wynnum: 6th September.
Beenleigh: 11th and 12th September.
Zillmere: 13th September.
Stephens: 20th September.
Rocklea: 27th September.
Kenilworth: 2nd October.
Toombul: 3rd and 4th October.
Southport: 10th October.

# IRRIGATION IN QUEENSLAND—IX.

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*The following tables and appendices are supplementary to Mr. Eklund's recently concluded series on Irrigation in Queensland.*

## TABLE I.

BAROMETRIC PRESSURE AT DIFFERENT ALTITUDES WITH EQUIVALENT HEAD OF WATER AND SUCTION LIFT OF PUMPS.

| Altitude. | Barometric Pressure. Lbs per square in. | Equivalent Head of Water. | Maximum Practical Suction Lift. |
|---|---|---|---|
| | | Feet. | Feet. |
| Sea level .. .. .. .. .. | 14·70 | 33·95 | 22·0 |
| ¼ mile—1,320 feet above sea level .. .. | 14·02 | 32·38 | 21·0 |
| ½ mile—2,640 feet above sea level .. .. | 13·33 | 30·79 | 20·0 |
| ¾ mile—3,960 feet above sea level .. .. | 12·66 | 29·24 | 18·5 |
| 1 mile—5,280 feet above sea level .. .. | 12·02 | 27·76 | 17·6 |
| 1¼ mile—6,600 feet above sea level .. | 11·42 | 26·38 | 16·7 |

## TABLE II.

AREA CROPPED.

| Year. | Sugar. | Maize. | Wheat. |
|---|---|---|---|
| | Acres. | Acres. | Acres. |
| 1906 .. .. .. .. | 133,284 | 139,806 | 114,575 |
| 1907 .. .. .. .. | 126,810 | 127,119 | 82,416 |
| 1908 .. .. .. .. | 123,902 | 127,655 | 80,898 |
| 1909 .. .. .. .. | 128,178 | 132,313 | 117,160 |
| 1910 .. .. .. .. | 141,779 | 180,862 | 106,718 |
| 1911 .. .. .. .. | 130,376 | 153,916 | 42,962 |
| 1912 .. .. .. .. | 141,652 | 117,993 | 124,963 |
| 1913 .. .. .. .. | 147,743 | 156,775 | 132,655 |
| 1914 .. .. .. .. | 161,195 | 176,372 | 127,015 |
| 1915 .. .. .. .. | 153,027 | 146,474 | 93,703 |

—From the Government Statistician's Report.

## TABLE III.

| Year. | Sugar. | Maize. | Wheat. |
|---|---|---|---|
| | Tons. | Bushels. | Bushels. |
| 1906 .. .. .. .. | 17·61 | 26·49 | 9·68 |
| 1907 .. .. .. .. | 17·64 | 24·34 | 8·41 |
| 1908 .. .. .. .. | 15·54 | 21·68 | 14·87 |
| 1909 .. .. .. .. | 14·53 | 18·96 | 13·41 |
| 1910 .. .. .. .. | 19·45 | 24·66 | 9·58 |
| 1911 .. .. .. .. | 16·02 | 23·63 | 6·64 |
| 1912 .. .. .. .. | 12·72 | 21·39 | 15·81 |
| 1913 .. .. .. .. | 20·29 | 24·97 | 13·34 |
| 1914 .. .. .. .. | 17·80 | 24·16 | 12·48 |
| 1915 .. .. .. .. | 12·20 | 13·68 | 4·43 |

—From the Government Statistician's Report.

TABLE III.—SHOWING AREAS ACTUALLY IRRIGATED IN QUEENSLAND EACH YEAR DURING THE LAST QUARTER CENTURY. (FROM STATISTICAL RECORDS.)

| District. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. |
|---|---|---|---|---|---|---|---|---|
| | Acres. | Acres. | Acres. | Acres. | Acres. | Acres. | Acres. | Acres. |
| Adavale | .. | .. | .. | .. | .. | 6 | 3 | .. |
| Allora | .. | .. | .. | .. | .. | .. | .. | .. |
| Aramac | .. | .. | .. | .. | .. | .. | .. | .. |
| Arillalah | 8 | .. | .. | .. | .. | .. | .. | .. |
| Augathella | .. | .. | .. | .. | .. | .. | 4 | .. |
| Ayr | 3,074 | 3,020 | 3,875 | 4,262 | 4,975 | 5,078 | 5,165 | 7,402 |
| Banana | .. | .. | .. | 1 | .. | 2 | 2 | .. |
| Barcaldine | .. | .. | 61½ | 87 | 58 | 137 | 172 | 205 |
| Beaudesert | .. | .. | .. | .. | .. | .. | .. | .. |
| Biggenden | .. | .. | .. | .. | .. | .. | .. | .. |
| Blackall | .. | .. | .. | 38 | 7 | 66 | 57 | 103 |
| Bollon | .. | .. | .. | .. | .. | .. | .. | .. |
| Bowen | 50 | 60 | 139½ | 95 | 70 | 146 | 158 | 63 |
| Brisbane | 4¾ | .. | 22¾ | 6 | 20 | 11 | 62 | 63 |
| Bundaberg | .. | .. | .. | .. | .. | .. | .. | .. |
| Burke | .. | .. | .. | 15 | 7 | .. | .. | .. |
| Burketown | .. | .. | .. | .. | .. | .. | .. | 6 |
| Caboolture | 10 | .. | .. | .. | .. | .. | .. | .. |
| Cairns | 2 | .. | .. | 10 | 3 | 3 | .. | .. |
| Camooweal | .. | .. | .. | .. | .. | .. | .. | .. |
| Cape River | .. | .. | 16 | 24 | 27 | 16 | 22 | 22 |
| Charleville | .. | .. | 9 | 7 | .. | 12 | 22 | 50 |
| Charters Towers | .. | .. | 151 | .. | .. | 17 | 16 | 20 |
| Clermont | .. | .. | .. | 4 | .. | .. | .. | 7 |
| Cleveland | .. | .. | 6 | 9 | 7 | 4 | 4 | 6 |
| Clifton | .. | .. | .. | .. | .. | .. | .. | .. |
| Cloncurry | .. | .. | .. | .. | .. | .. | 29 | .. |
| Cook | .. | .. | .. | 3 | 7 | 4 | 3 | 10 |
| Croydon | .. | 46 | .. | 41 | 29 | 11 | 10 | 14 |
| Cunnamulla | .. | .. | 5 | .. | 8 | 29 | 40 | 2 |
| Dalby | .. | .. | .. | .. | .. | .. | .. | .. |
| Diamantina | 3 | 3 | .. | .. | .. | .. | .. | .. |
| Douglas | .. | .. | 3 | .. | .. | .. | .. | 20 |
| Dugandan | .. | .. | .. | .. | .. | .. | .. | .. |
| Emerald | .. | .. | .. | .. | .. | .. | 10 | 10 |
| Esk | 110 | .. | .. | 20 | 20 | 25 | 91 | 225 |
| Etheridge | 1½ | 1½ | 7 | 25 | 13 | 13 | 10 | 4 |
| Gatton | 71 | .. | 55 | 40 | .. | .. | 4 | .. |
| Gayndah | .. | .. | .. | .. | .. | .. | .. | .. |
| Gin Gin | .. | .. | .. | 2 | .. | .. | 3 | 2 |
| Goondiwindi | .. | .. | .. | .. | .. | .. | .. | .. |
| Gympie | .. | .. | .. | .. | .. | .. | .. | .. |
| Harrisville | .. | .. | .. | 20 | 100 | .. | .. | .. |
| Herberton | .. | 5 | 1 | 4 | 4 | 12 | 6 | 5 |
| Highfields | .. | .. | .. | .. | .. | .. | .. | .. |
| Hughenden | 3½ | 7 | .. | 44 | 4 | 89 | 114 | 132 |
| Hungerford | .. | .. | .. | .. | .. | .. | .. | 13 |
| Ingham | .. | .. | .. | .. | .. | .. | .. | 2 |
| Inglewood | .. | .. | .. | 1 | .. | .. | .. | .. |
| Ipswich | .. | .. | .. | .. | .. | .. | .. | .. |
| Isisford | .. | .. | 11 | 19 | 13 | 11 | 14 | 7 |
| Jondaryan | .. | .. | .. | .. | .. | .. | .. | .. |
| Killarney | .. | .. | .. | .. | .. | .. | .. | .. |
| Laidley | .. | .. | .. | .. | 50 | .. | .. | .. |
| Leyburn | 130 | .. | .. | .. | .. | .. | .. | .. |
| Logan | 20½ | 5 | .. | .. | 5 | .. | .. | .. |
| Longreach | .. | .. | 1½ | 11 | .. | 20 | 4 | 1 |
| Mackay | 189 | 299 | 292 | 510 | 451 | 182 | 102 | 133 |
| Maroochy | .. | .. | .. | .. | .. | .. | 2 | .. |
| Maryborough | .. | .. | 7 | .. | 5 | .. | .. | .. |
| Mitchell | .. | .. | .. | .. | 12 | .. | .. | .. |
| Mourilyan | 186 | .. | .. | .. | .. | .. | .. | .. |
| Muttaburra | .. | .. | 9 | 11 | 9 | 11 | 11 | 26 |
| Nanango | .. | .. | .. | .. | .. | .. | .. | .. |
| Nerang | .. | .. | .. | .. | .. | .. | .. | .. |
| Norman | 18 | .. | .. | 13 | 8 | 17 | 19 | .. |
| Normanton | .. | 18 | .. | .. | .. | .. | .. | .. |
| Palmer | .. | .. | .. | .. | .. | .. | .. | .. |
| Ravenswood | .. | .. | .. | .. | .. | 5 | 4 | 8 |
| Redcliffe | .. | .. | .. | .. | .. | .. | .. | .. |
| Richmond | .. | .. | .. | .. | .. | .. | .. | .. |
| Rockhampton | .. | 6 | 170¼ | 44 | 39 | 70 | 65 | 738 |
| Roma | .. | .. | .. | .. | .. | .. | 10 | 21 |
| Rosewood | .. | .. | .. | .. | .. | .. | .. | .. |
| Somerset | .. | .. | .. | .. | .. | .. | .. | .. |
| Springsure | .. | .. | .. | .. | 3 | 2 | 4 | 2 |
| Stanthorpe | 25 | 37 | 50 | 70 | 3 | 116 | 45 | 8 |
| St. George | 4 | 5 | 11 | 18 | 23 | 42 | 50 | 45 |
| Surat | .. | .. | .. | .. | .. | .. | .. | 25 |
| Tambo | .. | .. | 1½ | .. | .. | 3 | 15 | 9 |
| Tara | 3 | .. | .. | .. | .. | .. | .. | .. |
| Taroom | .. | .. | .. | .. | .. | .. | 5 | 3 |
| Texas | .. | .. | .. | .. | .. | .. | .. | .. |
| Thargomindah | .. | .. | .. | .. | .. | 11 | 12 | 17 |
| Thornborough | 3 | 2 | 1½ | 1 | 2 | .. | 2 | 3 |
| Tiaro | .. | 4 | 31½ | 2 | .. | 2 | .. | .. |
| Toowoomba | .. | 85 | 102½ | 92 | 275 | 137 | 143 | 125 |
| Townsville | .. | 183½ | 329½ | 186 | 239 | 2,058* | 149 | 151 |
| Warwick | .. | 51 | 51 | .. | .. | .. | .. | .. |
| Windorah | .. | .. | 2 | 4 | .. | .. | 4 | .. |
| Woodford | .. | .. | .. | 25 | .. | .. | .. | .. |
| Other Districts | .. | .. | .. | 72 | .. | .. | .. | .. |
| Grand Totals | 3,896¼ | 3,838 | 5,286¾ | 5,846 | 6,456 | 8,368 | 6,647 | 9,588 |

* This appears to be an error in the statistical compilation.

TABLE III—SHOWING AREAS ACTUALLY IRRIGATED IN QUEENSLAND EACH YEAR DURING THE LAST QUARTER CENTURY. (FROM STATISTICAL RECORDS.)—*continued.*

| District. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907 |
|---|---|---|---|---|---|---|---|---|---|
| | Acres. | Acres. | Acres. | Acres. | Acres. | Acres. | Acres. | Acres. | Acres |
| Adavale | .. | .. | .. | 3 | .. | .. | .. | .. | .. |
| Allora | .. | .. | .. | 171 | 100 | .. | 120 | 72 | 82 |
| Aramac | .. | 6 | 4 | 17 | 18 | .. | .. | .. | .. |
| Arillalah | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Augathella | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Ayr | 4,825 | 4,726 | 3,896 | 4,070 | 3,622 | 4,334 | 4,678 | 4,978 | 4,492 |
| Banana | .. | 1 | 1 | 2 | .. | .. | .. | .. | .. |
| Barcaldine | 195 | 683 | 462 | 772 | 855 | 285 | 278 | 120 | 100 |
| Beaudesert | .. | .. | .. | 4 | 20 | .. | .. | .. | .. |
| Biggenden | .. | .. | .. | 1 | .. | .. | .. | .. | .. |
| Blackall | 119 | 40 | 28 | 18 | 29 | .. | .. | .. | .. |
| Bollon | .. | 21 | 9 | 8 | .. | .. | .. | .. | .. |
| Bowen | 109 | 126 | 162 | 201 | 286 | 265 | 278 | 295 | 356 |
| Brisbane | 51 | 45 | 44 | 56 | 68 | 64 | 66 | 64 | 15 |
| Bundaberg | .. | 150 | 210 | *2,906 | 4,410 | 5,848 | 5,858 | 2,526 | 2,350 |
| Burke | .. | 9 | 13 | 13 | 13 | .. | .. | .. | .. |
| Burketown | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Caboolture | .. | .. | .. | 1 | .. | .. | .. | .. | .. |
| Cairns | .. | 13 | 11 | 11 | 69 | .. | .. | .. | .. |
| Camooweal | .. | .. | .. | 1 | .. | .. | .. | .. | .. |
| Cape River | 23 | 49 | 39 | 18 | 21 | .. | .. | .. | .. |
| Charleville | 35 | 16 | 18 | 17 | 18 | .. | .. | .. | .. |
| Charters Towers | 28 | 33 | 47 | 35 | 31 | .. | 58 | 61 | 60 |
| Clermont | 14 | 5 | 5 | 4 | .. | .. | .. | .. | .. |
| Cleveland | 5 | 4 | 8 | 16 | 10 | .. | .. | .. | .. |
| Clifton | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Cloncurry | 12 | 14 | 14 | .. | .. | .. | .. | .. | .. |
| Cook | 45 | 6 | 15 | 11 | 39 | .. | .. | .. | .. |
| Croydon | 24 | .. | .. | .. | .. | .. | .. | .. | .. |
| Cunnamulla | 126 | 30 | 263 | †3,200 | 2,760 | 120 | 55 | 55 | 51 |
| Dalby | .. | .. | .. | 2 | .. | .. | .. | .. | .. |
| Diamantina | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Douglas | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Dugandan | .. | .. | 13 | 10 | .. | .. | .. | .. | .. |
| Emerald | 7 | 9 | 16 | 16 | 38 | .. | .. | .. | .. |
| Esk | .. | .. | 2 | 45 | 37 | .. | .. | .. | .. |
| Etheridge | 6 | 3 | 5 | 8 | .. | .. | .. | .. | .. |
| Gatton | 4 | .. | .. | 174 | 25 | 92 | 203 | 14 | 53 |
| Gayndah | .. | .. | .. | 1 | .. | .. | .. | .. | .. |
| Gin Gin | .. | .. | .. | 6 | .. | .. | .. | .. | .. |
| Goondiwindi | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Gympie | 14 | 42 | 48 | 25 | 21 | .. | .. | .. | .. |
| Harrisville | .. | .. | .. | 59 | .. | .. | .. | .. | 50 |
| Herberton | 7 | 4 | 17 | .. | .. | .. | .. | .. | .. |
| Highfields | .. | .. | .. | 5 | .. | .. | .. | .. | .. |
| Hughenden | 151 | 143 | 156 | 54 | 39 | .. | .. | .. | .. |
| Hungerford | 21 | 56 | 115 | 136 | 153 | 98 | 70 | 120 | 240 |
| Ingham | 2 | 5 | 80 | 70 | 70 | 170 | 206 | 21 | 28 |
| Inglewood | .. | .. | .. | .. | 30 | .. | .. | .. | .. |
| Ipswich | .. | 10 | 10 | 44 | 47 | .. | .. | .. | .. |
| Isisford | 6 | 4 | 2 | 1 | .. | .. | .. | .. | .. |
| Jondaryan | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Killarney | .. | .. | .. | 29 | .. | .. | .. | .. | .. |
| Laidley | .. | .. | .. | .. | 25 | .. | 50 | 15 | .. |
| Leyburn | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Logan | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Longreach | 17 | .. | 8 | 5 | 30 | .. | .. | .. | .. |
| Mackay | 93 | 229 | 304 | 496 | 514 | 542 | 125 | 127 | 20 |
| Maroochy | 2 | 1 | .. | .. | 15 | .. | .. | .. | .. |
| Maryborough | .. | .. | .. | 66 | 65 | 50 | 47 | 46 | 39 |
| Mitchell | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Mourilyan | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Muttaburra | 23 | 30 | 29 | 31 | 85 | .. | .. | .. | .. |
| Nanango | .. | .. | .. | 2 | .. | .. | .. | .. | .. |
| Nerang | .. | 30 | .. | 29 | 21 | .. | .. | .. | .. |
| Norman | .. | .. | 40 | 40 | 10 | .. | .. | .. | .. |
| Normanton | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Palmer | 3 | .. | .. | .. | .. | .. | .. | .. | .. |
| Ravenswood | 6 | 4 | 4 | 5 | .. | .. | .. | .. | .. |
| Redcliffe | .. | .. | .. | 25 | 20 | .. | .. | .. | .. |
| Richmond | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Rockhampton | 104 | 86 | 75 | 769 | 675 | 419 | 400 | 383 | 482 |
| Roma | 22 | 28 | 30 | 34 | 16 | .. | .. | .. | .. |
| Rosewood | .. | .. | .. | 23 | .. | .. | .. | .. | .. |
| Somerset | 2 | .. | .. | .. | .. | .. | .. | .. | .. |
| Springsure | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Stanthorpe | 13 | 12 | 36 | 27 | 25 | .. | .. | .. | .. |
| St. George | 31 | 27 | 44 | 46 | 40 | .. | .. | .. | .. |
| Surat | 12 | .. | 1 | .. | .. | .. | .. | .. | .. |
| Tambo | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Tara | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Taroom | 6 | 2 | 2 | 2 | .. | .. | .. | .. | .. |
| Texas | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Thargomindah | 15 | 3 | 1 | 1 | .. | .. | .. | .. | .. |
| Thornborough | 2 | .. | .. | .. | .. | .. | .. | .. | .. |
| Tiaro | 6 | 6 | 2 | .. | .. | .. | .. | .. | .. |
| Toowoomba | .. | .. | 15 | 168 | .. | .. | .. | .. | 124 |
| Townsville | 123 | 255 | 235 | 273 | 323 | 365 | 395 | 390 | 306 |
| Warwick | .. | .. | .. | 10 | .. | .. | 94 | 99 | 190 |
| Windorah | .. | 3 | .. | .. | .. | .. | .. | .. | .. |
| Woodford | .. | .. | .. | 18 | .. | .. | .. | .. | .. |
| Other Districts | .. | .. | .. | .. | 83 | 708 | 716 | 536 | 574 |
| Grand Totals | 6,311 | 6,969 | 6,526 | 14,344 | 14,786 | 13,360 | 13,693 | 9,922 | 9,612 |

* First year of operation of the large Bingera plant, described elsewhere.
† Hardly irrigation proper, as this appears to be a rough flooding of the plains for grasses.

TABLE III.—SHOWING AREAS ACTUALLY IRRIGATED IN QUEENSLAND EACH YEAR DURING THE LAST QUARTER CENTURY. (FROM STATISTICAL RECORDS.)—*continued.*

| District. | 1908. | 1909. | 1910. | 1911. | 1912. | 1913. | 1914. | 1915. | 1916. |
|---|---|---|---|---|---|---|---|---|---|
| | Acres. | Acres. | Acres. | Acres. | Acres. | Acres. | Acres. | Acres. | Acres. |
| Adavale | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Allora | 89 | 32 | 101 | 110 | 82 | 51 | .. | 59 | .. |
| Aramac | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Arillalah | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Augathella | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Ayr | 4,574 | 5,547 | 5,150 | 3,758 | 5,590 | 7,417 | 7,655 | 7,898 | 7,175 |
| Banana | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Barcaldine | 16 | 33 | .. | .. | .. | .. | .. | .. | .. |
| Beaudesert | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Biggenden | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Blackall | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Bollon | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Bowen | 385 | 130 | 398 | 556 | 670 | 645 | 589 | 492 | 525 |
| Brisbane | 28 | 65 | 62 | 61 | 110 | 89 | 114 | 142 | 144 |
| Bundaberg | 811 | 256 | 203 | 2,103 | 206 | 193 | 114 | 195 | 264 |
| Burke | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Burketown | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Caboolture | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Cairns | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Camooweal | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Cape River | .. | .. | .. | .. | .. | .. | .. | .. | 36 |
| Charleville | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Charters Towers | 51 | 45 | 48 | 69 | 73 | 61 | 66 | 61 | 56 |
| Clermont | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Cleveland | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Clifton | .. | .. | 40 | 47 | 113 | 135 | 46 | 83 | .. |
| Cloncurry | .. | .. | 43 | 40 | 34 | .. | 47 | 44 | .. |
| Cook | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Croydon | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Cunnamulla | 175 | 184 | 176 | 38 | 123 | 496 | 568 | 435 | 420 |
| Dalby | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Diamantina | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Douglas | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Dugandan | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Emerald | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Esk | .. | .. | .. | .. | 67 | .. | .. | 52 | 36 |
| Etheridge | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Gatton | 19 | 44 | .. | .. | .. | .. | .. | .. | .. |
| Gayndah | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Gin Gin | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Goondiwindi | .. | .. | .. | .. | 47 | 40 | .. | .. | .. |
| Gympie | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Harrisville | 10 | 101 | 50 | 74 | 82 | 87 | 60 | 147 | 37 |
| Herberton | .. | .. | .. | 35 | 57 | 44 | .. | .. | .. |
| Highfields | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Hughenden | 64 | 64 | 61 | 61 | 61 | 60 | 65 | 60 | 60 |
| Hungerford | 240 | 240 | 250 | 250 | 250 | 250 | 250 | .. | .. |
| Ingham | .. | .. | .. | .. | .. | 90 | 90 | 38 | 36 |
| Inglewood | .. | .. | 37 | .. | .. | 70 | 67 | 43 | 60 |
| Ipswich | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Isisford | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Jondaryan | .. | .. | 63 | .. | .. | .. | .. | .. | .. |
| Killarney | .. | .. | .. | .. | .. | .. | .. | 47 | 50 |
| Laidley | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Leyburn | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Logan | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Longreach | 31 | 28 | .. | .. | .. | .. | .. | .. | .. |
| Mackay | 22 | 18 | .. | 35 | 45 | 47 | 58 | 44 | .. |
| Maroochy | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Maryborough | 46 | 40 | 41 | 47 | .. | .. | .. | .. | 30 |
| Mitchell | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Mourilyan | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Muttaburra | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Nanango | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Nerang | .. | .. | .. | .. | .. | .. | .. | .. | 48 |
| Norman | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Normanton | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Palmer | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Ravenswood | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Redcliffe | .. | .. | .. | .. | .. | .. | .. | 41 | 57 |
| Richmond | .. | .. | 31 | 40 | 40 | 40 | .. | .. | .. |
| Rockhampton | 532 | 218 | 201 | 231 | 485 | 509 | 320 | 464 | 498 |
| Roma | .. | .. | .. | .. | .. | .. | 50 | .. | .. |
| Rosewood | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Somerset | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Springsure | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Stanthorpe | .. | .. | 55 | 90 | 70 | 67 | 80 | 65 | 30 |
| St. George | 40 | 43 | 51 | 48 | 43 | 47 | .. | .. | 39 |
| Surat | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Tambo | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Tara | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Taroom | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Texas | .. | .. | .. | .. | 55 | 79 | 57 | .. | .. |
| Thargomindah | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Thornborough | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Tiaro | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Toowoomba | 14 | 20 | 30 | .. | .. | 43 | 92 | 90 | 89 |
| Townsville | 309 | 361 | 356 | 332 | 396 | 487 | 477 | 473 | 421 |
| Warwick | 231 | 160 | 34 | 180 | 113 | 104 | 111 | 106 | 146 |
| Windorah | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Woodford | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Other Districts | 500 | 541 | 525 | 456 | 608 | 702 | 833 | 763 | 629 |
| Grand Totals | 8,247 | 8,470 | 8,006 | 8,661 | 9,420 | 11,856 | 11,809 | 11,842 | 12,402 |

TABLE IV.

PUMPING CAPACITY OF WINDMILLS.

CYLINDER AND LENGTH OF STROKE BASED ON A WIND VELOCITY OF 10 MILES PER HOUR.

| Diameter of Wheel. | Length of Stroke. | Diameter of Cylinder. | R.P.M. | Gallons per Hour. | Diameter of Cylinder. | R.P.M. | Gallons per Hour. |
|---|---|---|---|---|---|---|---|
| | | 25 FEET ELEVATION. | | | 50 FEET ELEVATION. | | |
| | Inch. | Inch. | | | Inch. | | |
| 8 feet .. .. | 6 | 4 | 40 | 651 | 3 | 40 | 367 |
| 8 feet .. .. | 8 | 3½ | 40 | 665 | 2½ | 40 | 340 |
| 10 feet .. .. | 6 | 5 | 35 | 892 | 4 | 35 | 570 |
| 10 feet .. .. | 8 | 4½ | 35 | 964 | 3½ | 35 | 582 |
| 12 feet .. .. | 8 | 6 | 30 | 1,467 | 5 | 30 | 1,020 |
| 12 feet .. .. | 10 | 6 | 30 | 1,850 | 4¾ | 30 | 1,140 |
| 12 feet .. .. | 12 | 6 | 30 | 2,200 | 4½ | 30 | 1,230 |
| 14 feet .. .. | 10 | 6 | 25 | 1,530 | 5¾ | 25 | 1,400 |
| 14 feet .. .. | 12 | 6 | 25 | 1,850 | 5 | 25 | 1,270 |
| 16 feet .. .. | 12 | 8 | 20 | 2,610 | 8 | 20 | 2,610 |
| 16 feet .. .. | 16 | 8¾ | 20 | 4,100 | 7¾ | 20 | 3,260 |
| | | 75 FEET ELEVATION. | | | 100 FEET ELEVATION. | | |
| 8 feet .. .. | 6 | 2½ | 40 | 255 | 2¼ | 36 | 187 |
| 8 feet .. .. | 8 | 2¼ | 40 | 275 | 2 | 36 | 198 |
| 10 feet .. .. | 6 | 3½ | 35 | 495 | 3¼ | 32 | 342 |
| 10 feet .. .. | 8 | 3 | 35 | 428 | 2⅝ | 32 | 328 |
| 12 feet .. .. | 8 | 4½ | 30 | 825 | 3½ | 27·5 | 455 |
| 12 feet .. .. | 10 | 4 | 30 | 809 | 3½ | 27·5 | 570 |
| 12 feet .. .. | 12 | 4 | 30 | 940 | 3¼ | 27·5 | 589 |
| 14 feet .. .. | 10 | 4½ | 25 | 863 | 4 | 22·5 | 620 |
| 14 feet .. .. | 12 | 4 | 25 | 809 | 3½ | 22·5 | 569 |
| 16 feet .. .. | 12 | 6 | 20 | 1,570 | 6 | 20 | 1,570 |
| 16 feet .. .. | 16 | 6 | 20 | 1,860 | 5 | 18 | 1,240 |
| | | 125 FEET ELEVATION. | | | 150 FEET ELEVATION. | | |
| 8 feet .. .. | 6 | 2 | 36 | 149 | .. | .. | .. |
| 8 feet .. .. | 8 | .. | .. | .. | .. | .. | .. |
| 10 feet .. .. | 6 | 2⅜ | 32 | 245 | 2½ | 32 | 203 |
| 10 feet .. .. | 8 | 2¼ | 32 | 219 | 2 | 32 | 173 |
| 12 feet .. .. | 8 | 3½ | 27·5 | 455 | 3½ | 27·5 | 392 |
| 12 feet .. .. | 10 | 3¼ | 27·5 | 491 | 3 | 27·5 | 418 |
| 12 feet .. .. | 12 | 2⅝ | 27·5 | 422 | 2½ | 27·5 | 348 |
| 14 feet .. .. | 10 | 3½ | 22·5 | 475 | 3¼ | 22·5 | 408 |
| 14 feet .. .. | 12 | 3¼ | 22·5 | 490 | 3 | 22·5 | 418 |
| 16 feet .. .. | 12 | 5 | 20 | 1,060 | 5 | 20 | 1,060 |
| 16 feet .. .. | 16 | 4½ | 18 | 1,000 | 4¼ | 18 | 896 |
| | | 175 FEET ELEVATION. | | | 225 FEET ELEVATION. | | |
| 8 feet .. .. | 6 | .. | .. | .. | .. | .. | .. |
| 8 feet .. .. | 8 | .. | .. | .. | .. | .. | .. |
| 10 feet .. .. | 6 | 2 | 32 | 120 | .. | .. | .. |
| 10 feet .. .. | 8 | .. | .. | .. | .. | .. | .. |
| 12 feet .. .. | 8 | 3 | 27·5 | 385 | 2½ | 27·5 | .. |
| 12 feet .. .. | 10 | 2⅝ | 27·5 | 351 | 2¼ | 27·5 | .. |
| 12 feet .. .. | 12 | 2½ | 27·5 | 348 | 2 | 27·5 | .. |
| 14 feet .. .. | 10 | 3 | 22·5 | 348 | 2⅝ | 22·5 | .. |
| 14 feet .. .. | 12 | 2¾ | 22·5 | 351 | 2½ | 22·5 | .. |
| 16 feet .. .. | 12 | 4½ | 18 | 753 | 4 | 18 | 595 |
| 16 feet .. .. | 16 | 4 | 18 | 705 | 3½ | 18 | 607 |

This Table, based on practice, is made to show that the larger mill does not necessarily raise a greater quantity of water, unless both stroke and diameter of cylinder are correctly proportioned to do the maximum amount of work. In fact, owing to the lower angular velocity of the larger mills, with the same size pump, a small mill will raise more water at low heads than large mills.

TABLE V.

METEOROLOGICAL OBSERVATIONS AT BRISBANE OBSERVATORY OF WIND VELOCITIES IN MILES PER HOUR.

| Month. | 9 a.m. | 3 p.m. | 9 p.m. | Average. |
|---|---|---|---|---|
| 1914— | | | | |
| January .. | 4·7 | 10·3 | 4·9 | 6·6 |
| February .. | 7·7 | 12·1 | 6·1 | 8·6 |
| March .. | 4·2 | 7·9 | 3·2 | 5·1 |
| April .. | 2·7 | 5·6 | 2·2 | 3·5 |
| May .. | 4·4 | 6·2 | 2·3 | 4·3 |
| June .. | 5·7 | 6·0 | 3·6 | 5·1 |
| July .. | 4·4 | 5·7 | 2·2 | 4·1 |
| August .. | 5·1 | 7·1 | 3·3 | 5·1 |
| September .. | 3·5 | 7·6 | 3·5 | 4·8 |
| October .. | 5·0 | 8·5 | 4·6 | 6·0 |
| November .. | 4·0 | 9·3 | 5·6 | 6·3 |
| December .. | 2·6 | 6·7 | 4·8 | 4·0 |
| Average for year .. | 4·5 | 7·7 | 3·9 | 5·3 |
| 1915— | | | | |
| January .. | 3·3 | 7·8 | 3·8 | 4·9 |
| February .. | 3·8 | 7·7 | 5·0 | 5·5 |
| March .. | 2·3 | 7·4 | 3·9 | 4·5 |
| April .. | 1·8 | 5·8 | 2·8 | 3·5 |
| May .. | 1·5 | 4·0 | 3·2 | 2·9 |
| June .. | 2·1 | 5·7 | 3·7 | 3·6 |
| July .. | 1·1 | 2·9 | 3·0 | 3·3 |
| August .. | 1·4 | 5·3 | 3·6 | 3·4 |
| September .. | 2·9 | 8·6 | 3·6 | 5·0 |
| October .. | 5·2 | 7·4 | 4·6 | 5·7 |
| November .. | 4·9 | 11·8 | 5·5 | 7·4 |
| December .. | 7·3 | 11·5 | 5·7 | 8·2 |
| Average for year .. | 3·1 | 7·1 | 4·1 | 4·8 |
| 1916— | | | | |
| January .. | 5·3 | 11·8 | 5·8 | 7·6 |
| February .. | 5·3 | 9·4 | 5·5 | 6·7 |
| March .. | 4·4 | 9·1 | 4·3 | 5·9 |
| April .. | 4·5 | 6·2 | 3·7 | 4·8 |
| May .. | 5·0 | 6·6 | 2·4 | 4·7 |
| June .. | 4·9 | 6·7 | 3·2 | 4·9 |
| July .. | 4·7 | 5·7 | 3·2 | 4·5 |
| August .. | 4·9 | 7·7 | 3·4 | 5·3 |
| September .. | 4·4 | 8·3 | 3·3 | 5·3 |
| October .. | 5·0 | 8·0 | 4·2 | 5·7 |
| November .. | 5·1 | 9·7 | 5·2 | 6·6 |
| December .. | 6·8 | 9·9 | 4·0 | 7·0 |
| Average for year .. | 5·0 | 8·2 | 4·0 | 5·8 |
| 1917— | | | | |
| January .. | 5·0 | 9·6 | 3·4 | .. |
| February .. | 6·3 | 9·2 | 4·4 | .. |
| March .. | 5·5 | 8·0 | 3·6 | .. |
| April .. | 5·2 | 6·7 | 3·8 | .. |

## TABLE VI.

### FRICTION OF WATER IN PIPES PER 100 FEET LENGTH.

| Velocity of Water in Feet per Second. | Head in Feet to Produce this Velocity. | INTERNAL DIAMETER OF PIPE IN INCHES. | | | | | |
|---|---|---|---|---|---|---|---|
| | | Head to Overcome Friction. | Gallons per Minute. | Head to Overcome Friction. | Gallons per Minute. | Head to Overcome Friction. | Gallons per Minute. |
| | | 3-inch. | | 4-inch. | | 5-inch. | |
| 1·0 | ·016 | ·215 | 18·3 | ·150 | 32·4 | ·114 | 50·5 |
| 2·0 | ·062 | ·786 | 36·7 | ·548 | 64·8 | ·415 | 101 |
| 2·2 | ·075 | ·939 | 40·4 | ·656 | 71·7 | ·496 | 112 |
| 2·4 | ·090 | 1·11 | 44·1 | ·771 | 78 | ·583 | 122 |
| 2·6 | ·105 | 1·28 | 44·7 | ·896 | 84·8 | ·678 | 132 |
| 2·8 | ·122 | 1·47 | 52·4 | 1·03 | 91·1 | ·778 | 142 |
| 3·0 | ·140 | 1·68 | 55·0 | 1·17 | 97·9 | ·886 | 152 |
| 3·2 | ·160 | 1·89 | 58·7 | 1·32 | 104 | ·999 | 163 |
| 3·4 | ·180 | 2·12 | 62·4 | 1·48 | 111 | 1·12 | 173 |
| 3·6 | ·202 | 2·36 | 66·1 | 1·65 | 117 | 1·25 | 183 |
| 3·8 | ·225 | 2·61 | 69·8 | 1·82 | 124 | 1·38 | 193 |
| 4·0 | ·250 | 2·87 | 73·6 | 2·01 | 130 | 1·52 | 204 |
| 4·2 | ·275 | 3·15 | 76·7 | 2·20 | 137 | 1·66 | 214 |
| 4·4 | ·302 | 3·43 | 80·4 | 2·40 | 143 | 1·81 | 224 |
| 4·6 | ·330 | 3·73 | 84·2 | 2·60 | 149 | 1·97 | 234 |
| 4·8 | ·360 | 4·04 | 87·9 | 2·82 | 156 | 2·13 | 244 |
| 5·0 | ·390 | 4·36 | 91·7 | 3·04 | 163 | 2·30 | 254 |
| 5·2 | ·422 | 4·69 | 95·4 | 3·27 | 169 | 2·48 | 265 |
| 5·4 | ·455 | 5·03 | 99·2 | 3·51 | 175 | 2·66 | 275 |
| 5·6 | ·490 | 5·39 | 102 | 3·76 | 182 | 2·85 | 285 |
| 5·8 | ·525 | 5·75 | 106 | 4·02 | 189 | 3·04 | 295 |
| 6·0 | ·562 | 6·13 | 110 | 4·28 | 195 | 3·24 | 305 |
| 6·2 | ·600 | 6·52 | 113 | 4·55 | 202 | 3·44 | 316 |
| 6·4 | ·640 | 6·92 | 117 | 4·83 | 209 | 3·65 | 326 |
| 6·6 | ·680 | 7·33 | 121 | 5·11 | 215 | 3·87 | 336 |
| 6·8 | ·722 | 7·75 | 124 | 5·41 | 222 | 4·09 | 346 |
| 7·0 | ·765 | 8·18 | 128 | 5·71 | 228 | 4·32 | 356 |
| | | 6-inch. | | 7-inch. | | 8-inch. | |
| 1·0 | ·016 | ·090 | 73 | ·075 | 99·5 | ·063 | 130·5 |
| 2·0 | ·062 | ·330 | 146 | ·273 | 199 | ·231 | 261 |
| 2·2 | ·075 | ·395 | 161 | ·326 | 220 | ·276 | 287 |
| 2·4 | ·090 | ·465 | 175 | ·383 | 240 | ·324 | 313 |
| 2·6 | ·105 | ·540 | 190 | ·445 | 260 | ·377 | 339 |
| 2·8 | ·122 | ·620 | 205 | ·511 | 280 | ·433 | 365 |
| 3·0 | ·140 | ·705 | 220 | ·582 | 300 | ·492 | 391 |
| 3·2 | ·160 | ·796 | 235 | ·656 | 320 | ·555 | 418 |
| 3·4 | ·180 | ·891 | 249 | ·735 | 340 | ·622 | 444 |
| 3·6 | ·202 | ·992 | 264 | ·818 | 360 | ·692 | 470 |
| 3·8 | ·225 | 1·10 | 278 | ·905 | 380 | ·766 | 496 |
| 4·0 | ·250 | 1·21 | 293 | ·998 | 399 | ·845 | 522 |
| 4·2 | ·275 | 1·32 | 308 | 1·09 | 419 | ·924 | 548 |
| 4·4 | ·302 | 1·44 | 313 | 1·19 | 439 | 1·01 | 574 |
| 4·6 | ·330 | 1·57 | 337 | 1·29 | 459 | 1·10 | 600 |
| 4·8 | ·360 | 1·70 | 352 | 1·40 | 479 | 1·19 | 624 |
| 5·0 | ·390 | 1·83 | 367 | 1·51 | 499 | 1·28 | 655 |
| 5·2 | ·422 | 1·97 | 381 | 1·63 | 519 | 1·37 | 680 |
| 5·4 | ·455 | 2·12 | 396 | 1·75 | 540 | 1·47 | 705 |
| 5·6 | ·490 | 2·27 | 411 | 1·87 | 560 | 1·58 | 730 |
| 5·8 | ·525 | 2·42 | 426 | 2·00 | 580 | 1·69 | 755 |
| 6·0 | ·562 | 2·58 | 441 | 2·13 | 600 | 1·80 | 780 |
| 6·2 | ·600 | 2·74 | 455 | 2·26 | 620 | 1·91 | 811 |
| 6·4 | ·640 | 2·91 | 470 | 2·40 | 641 | 2·03 | 836 |
| 6·6 | ·680 | 3·08 | 484 | 2·54 | 661 | 2·15 | 861 |
| 6·8 | ·722 | 3·26 | 499 | 2·69 | 681 | 2·27 | 886 |
| 7·0 | ·765 | 3·44 | 514 | 2·84 | 701 | 2·40 | 911 |
| | | 9-inch. | | 10-inch. | | 11-inch. | |
| 1·0 | ·016 | ·055 | 165 | ·048 | 204 | ·042 | 247 |
| 2·0 | ·062 | ·199 | 330 | ·174 | 408 | ·155 | 494 |
| 2·2 | ·075 | ·238 | 363 | ·208 | 449 | ·185 | 543 |
| 2·4 | ·090 | ·280 | 396 | ·245 | 489 | ·218 | 592 |
| 2·6 | ·105 | ·325 | 429 | ·285 | 530 | ·253 | 641 |
| 2·8 | ·122 | ·373 | 463 | ·327 | 571 | ·291 | 690 |
| 3·0 | ·140 | ·425 | 496 | ·372 | 612 | ·331 | 740 |
| 3·2 | ·160 | ·479 | 529 | ·420 | 653 | ·373 | 789 |
| 3·4 | ·180 | ·537 | 562 | ·471 | 693 | ·418 | 838 |
| 3·6 | ·202 | ·597 | 595 | ·524 | 734 | ·465 | 887 |
| 3·8 | ·225 | ·661 | 630 | ·580 | 775 | ·515 | 937 |
| 4·0 | ·250 | ·729 | 661 | ·639 | 817 | ·567 | 987 |
| 4·2 | ·275 | ·797 | 692 | ·699 | 857 | ·620 | 1,036 |
| 4·4 | ·302 | ·870 | 723 | ·762 | 897 | ·676 | 1,085 |
| 4·6 | ·330 | ·945 | 761 | ·828 | 938 | ·735 | 1,134 |
| 4·8 | ·360 | 1·02 | 792 | ·897 | 979 | ·796 | 1,184 |
| 5·0 | ·390 | 1·10 | 823 | ·968 | 1,019 | ·859 | 1,234 |
| 5·2 | ·422 | 1·19 | 861 | 1·04 | 1,060 | ·925 | 1,283 |
| 5·4 | ·455 | 1·28 | 892 | 1·12 | 1,111 | ·993 | 1,332 |
| 5·6 | ·490 | 1·37 | 923 | 1·20 | 1,142 | 1·063 | 1,381 |
| 5·8 | ·525 | 1·46 | 960 | 1·28 | 1,183 | 1·134 | 1,430 |
| 6·0 | ·562 | 1·55 | 992 | 1·36 | 1,224 | 1·208 | 1,480 |
| 6·2 | ·600 | 1·65 | 1,023 | 1·45 | 1,264 | 1·284 | 1,529 |
| 6·4 | ·640 | 1·75 | 1,054 | 1·54 | 1,305 | 1·363 | 1,578 |
| 6·6 | ·680 | 1·86 | 1,092 | 1·63 | 1,346 | 1·444 | 1,627 |
| 6·8 | ·722 | 1·97 | 1,123 | 1·72 | 1,387 | 1·527 | 1,677 |
| 7·0 | ·765 | 2·08 | 1,144 | 1·82 | 1,428 | 1·612 | 1,727 |

TABLE VI.—*continued.*

FRICTION OF WATER IN PIPES PER 100 FEET LENGTH—*continued.*

| Velocity of Water in Feet per Second. | Head in Feet to Produce this Velocity. | INTERNAL DIAMETER OF PIPE IN INCHES. | | | | | |
|---|---|---|---|---|---|---|---|
| | | Head to Overcome Friction. | Gallons per Minute. | Head to Overcome Friction. | Gallons per Minute. | Head to Overcome Friction. | Gallons per Minute. |
| | | 12-inch. | | 14-inch. | | 15-inch. | |
| 1·0 | ·016 | ·038 | 294 | ·031 | 400 | ·029 | 459 |
| 2·0 | ·062 | ·139 | 587 | ·115 | 799 | ·105 | 917 |
| 2·2 | ·075 | ·166 | 646 | ·137 | 879 | ·126 | 1,009 |
| 2·4 | ·090 | ·195 | 705 | ·161 | 959 | ·148 | 1,101 |
| 2·6 | ·105 | ·227 | 764 | ·187 | 1,039 | ·172 | 1,193 |
| 2·8 | ·122 | ·261 | 823 | ·215 | 1,119 | ·197 | 1,284 |
| 3·0 | ·140 | ·297 | 881 | ·245 | 1,199 | ·224 | 1,376 |
| 3·2 | ·160 | ·335 | 940 | ·276 | 1,279 | ·253 | 1,468 |
| 3·4 | ·180 | ·375 | 999 | ·309 | 1,359 | ·283 | 1,559 |
| 3·6 | ·202 | ·417 | 1,058 | ·344 | 1,439 | ·315 | 1,651 |
| 3·8 | ·225 | ·462 | 1,117 | ·381 | 1,519 | ·349 | 1,743 |
| 4·0 | ·250 | ·509 | 1,175 | ·419 | 1,599 | ·385 | 1,835 |
| 4·2 | ·275 | ·557 | 1,234 | ·459 | 1,679 | ·421 | 1,926 |
| 4·4 | ·302 | ·607 | 1,293 | ·501 | 1,759 | ·459 | 2,017 |
| 4·6 | ·330 | ·659 | 1,352 | ·544 | 1,839 | ·499 | 2,109 |
| 4·8 | ·360 | ·714 | 1,411 | ·589 | 1,919 | ·540 | 2,201 |
| 5·0 | ·390 | ·771 | 1,468 | ·636 | 1,999 | ·583 | 2,294 |
| 5·2 | ·422 | ·829 | 1,527 | ·684 | 2,079 | ·627 | 2,386 |
| 5·4 | ·455 | ·890 | 1,586 | ·734 | 2,159 | ·673 | 2,478 |
| 5·6 | ·490 | ·953 | 1,645 | ·786 | 2,239 | ·721 | 2,569 |
| 5·8 | ·525 | 1·018 | 1,704 | ·839 | 2,319 | ·770 | 2,660 |
| 6·0 | ·562 | 1·084 | 1,762 | ·894 | 2,399 | ·820 | 2,752 |
| 6·2 | ·600 | 1·152 | 1,821 | ·950 | 2,479 | ·872 | 2,844 |
| 6·4 | ·640 | 1·222 | 1,880 | 1·009 | 2,559 | ·925 | 2,936 |
| 6·6 | ·680 | 1·295 | 1,939 | 1·069 | 2,639 | ·980 | 3,027 |
| 6·8 | ·722 | 1·369 | 1,998 | 1·130 | 2,719 | 1·036 | 3,118 |
| 7·0 | ·765 | 1·446 | 2,056 | 1·193 | 2,799 | 1·094 | 3,210 |
| | | 16-inch. | | 18-inch. | | 20-inch. | |
| 1·0 | ·016 | ·026 | 522 | ·023 | 661 | ·020 | 816 |
| 2·0 | ·062 | ·097 | 1,044 | ·084 | 1,322 | ·073 | 1,632 |
| 2·2 | ·075 | ·116 | 1,149 | ·100 | 1,454 | ·088 | 1,795 |
| 2·4 | ·090 | ·126 | 1,254 | ·118 | 1,584 | ·103 | 1,958 |
| 2·6 | ·105 | ·159 | 1,359 | ·137 | 1,716 | ·120 | 2,121 |
| 2·8 | ·122 | ·182 | 1,464 | ·157 | 1,849 | ·138 | 2,284 |
| 3·0 | ·140 | ·207 | 1,566 | ·179 | 1,982 | ·157 | 2,444 |
| 3·2 | ·160 | ·233 | 1,671 | ·202 | 2,114 | ·177 | 2,610 |
| 3·4 | ·180 | ·261 | 1,776 | ·226 | 2,246 | ·198 | 2,774 |
| 3·6 | ·202 | ·291 | 1,880 | ·251 | 2,378 | ·220 | 2,937 |
| 3·8 | ·225 | ·322 | 1,984 | ·278 | 2,512 | ·243 | 3,100 |
| 4·0 | ·250 | ·355 | 2,088 | ·306 | 2,643 | ·268 | 3,263 |
| 4·2 | ·275 | ·389 | 2,193 | ·335 | 2,775 | ·294 | 3,426 |
| 4·4 | ·302 | ·424 | 2,298 | ·366 | 2,908 | ·321 | 3,589 |
| 4·6 | ·330 | ·460 | 2,402 | ·398 | 3,040 | ·348 | 3,752 |
| 4·8 | ·360 | ·498 | 2,506 | ·431 | 3,172 | ·377 | 3,916 |
| 5·0 | ·390 | ·538 | 2,611 | ·465 | 3,304 | ·407 | 4,080 |
| 5·2 | ·422 | ·579 | 2,716 | ·500 | 3,436 | ·438 | 4,243 |
| 5·4 | ·455 | ·621 | 2,820 | ·536 | 3,568 | ·470 | 4,406 |
| 5·6 | ·490 | ·665 | 2,925 | ·574 | 3,700 | ·503 | 4,569 |
| 5·8 | ·525 | ·710 | 3,029 | ·613 | 3,832 | ·537 | 4,732 |
| 6·0 | ·562 | ·757 | 3,133 | ·653 | 3,965 | ·572 | 4,895 |
| 6·2 | ·600 | ·805 | 3,238 | ·694 | 4,098 | ·608 | 5,058 |
| 6·4 | ·640 | ·854 | 3,342 | ·736 | 4,230 | ·646 | 5,221 |
| 6·6 | ·680 | ·904 | 3,447 | ·780 | 4,362 | ·684 | 5,384 |
| 6·8 | ·722 | ·956 | 3,551 | ·825 | 4,494 | ·723 | 5,547 |
| 7·0 | ·765 | 1·010 | 3,655 | ·871 | 4,625 | ·763 | 5,711 |
| | | 21-inch. | | 22-inch. | | 24-inch. | |
| 1·0 | ·016 | ·019 | 900 | ·018 | 986 | ·016 | 1,175 |
| 2·0 | ·062 | ·069 | 1,799 | ·065 | 1,974 | ·058 | 2,349 |
| 2·2 | ·075 | ·082 | 1,979 | ·078 | 2,172 | ·070 | 2,584 |
| 2·4 | ·090 | ·097 | 2,158 | ·092 | 2,370 | ·082 | 2,818 |
| 2·6 | ·105 | ·113 | 2,338 | ·107 | 2,568 | ·095 | 3,053 |
| 2·8 | ·122 | ·130 | 2,518 | ·122 | 2,765 | ·110 | 3,289 |
| 3·0 | ·140 | ·148 | 2,698 | ·139 | 2,961 | ·125 | 3,524 |
| 3·2 | ·160 | ·166 | 2,878 | ·157 | 3,159 | ·141 | 3,759 |
| 3·4 | ·180 | ·186 | 3,058 | ·176 | 3,357 | ·158 | 3,994 |
| 3·6 | ·202 | ·207 | 3,238 | ·195 | 3,555 | ·175 | 4,229 |
| 3·8 | ·225 | ·229 | 3,417 | ·216 | 3,752 | ·194 | 4,464 |
| 4·0 | ·250 | ·252 | 3,597 | ·238 | 3,948 | ·214 | 4,699 |
| 4·2 | ·275 | ·276 | 3,777 | ·261 | 4,145 | ·234 | 4,934 |
| 4·4 | ·302 | ·301 | 3,957 | ·284 | 4,343 | ·255 | 5,170 |
| 4·6 | ·330 | ·328 | 4,137 | ·309 | 4,540 | ·277 | 5,414 |
| 4·8 | ·360 | ·355 | 4,316 | ·335 | 4,738 | ·300 | 5,649 |
| 5·0 | ·390 | ·383 | 4,496 | ·361 | 4,935 | ·324 | 5,873 |
| 5·2 | ·422 | ·412 | 4,676 | ·389 | 5,132 | ·349 | 6,108 |
| 5·4 | ·455 | ·442 | 4,856 | ·417 | 5,330 | ·374 | 6,343 |
| 5·6 | ·490 | ·473 | 5,036 | ·446 | 5,528 | ·401 | 6,578 |
| 5·8 | ·525 | ·505 | 5,216 | ·477 | 5,725 | ·428 | 6,813 |
| 6·0 | ·562 | ·538 | 5,396 | ·508 | 5,922 | ·456 | 7,048 |
| 6·2 | ·600 | ·572 | 5,576 | ·540 | 6,120 | ·485 | 7,283 |
| 6·4 | ·640 | ·608 | 5,756 | ·573 | 6,318 | ·514 | 7,515 |
| 6·6 | ·680 | ·644 | 5,936 | ·607 | 6,515 | ·544 | 7,750 |
| 6·8 | ·722 | ·681 | 6,115 | ·642 | 6,712 | ·576 | 7,986 |
| 7·0 | ·765 | ·719 | 6,285 | ·678 | 6,909 | ·608 | 8,223 |

## TABLE VII.

### Weight and Bulk of Water.

Weight of 1 cubic foot of water 62·228 to 62·355 (according to temperature).

*Fresh Water at 62 Degrees F.*

1 cubic foot = 6·2321 gallons.
1 gallon = 10 lbs.
1 gallon = ·161 cubic foot.
1 gallon = 277¼ cubic inches (approximate).
1 ton = 36 cubic feet (approximate).
1 acre inch = 100 tons (approximate).

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### Weight and Capacity of Different Standard Gallons of Water.

| | Cubic Inches in One Gallon. | Weight of One Gallon in Lbs. | Gallons in One Cubic Foot. |
|---|---|---|---|
| Imperial or English .. .. .. | 277·274 | 10·000 | 6·2321 |
| U.S.A. or American .. .. .. | 231·000 | 8·3356 | 7·480 |

1 acre foot—66 by 660 by 1 = 43,560 cubic feet.
66 by 660 by 6·2321 = 271,470 gallons.

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1 acre inch = 22,622 gallons.
2 acre inches = 45,244 gallons
3 acre inches = 67,866 gallons.
4 acre inches = 90,488 gallons.
5 acre inches = 113,110 gallons.
6 acre inches = 135,732 gallons.
7 acre inches = 158,354 gallons.
8 acre inches = 180,976 gallons.
9 acre inches = 203,598 gallons.
10 acre inches = 226,220 gallons.
11 acre inches = 248,842 gallons.

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## TABLE VIII.

WEIR MEASUREMENT TABLE FOR WEIR 2 FEET WIDE (BY FRANCIS FORMULÆ).

| Depth of Water over Lip of Weir. From Still Water. | | Discharge. | | | Time Required to Pump Acre Inches as below. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Gallons per Minute. | Gallons per Day. | Acre. Inches per Hour. | 1 | | 2 | | 3 | |
| Inches. | Feet. | | | | Hrs. | Mins. | Hrs. | Mins. | Hrs. | Mins. |
| 1 .. | ·083 | 59·4 | 85,564 | ·16 | 6 | 26 | 12 | 52 | .. | |
| 1 1/16 .. | ·088 | 65·1 | 93,696 | ·17 | 5 | 48 | 11 | 36 | .. | |
| 1 1/8 .. | ·094 | 70·9 | 102,030 | ·19 | 5 | 19 | 10 | 38 | .. | |
| 1 3/16 .. | ·099 | 76·8 | 110,592 | ·20 | 4 | 56 | 9 | 52 | .. | |
| 1 1/4 .. | ·104 | 82·9 | 119,367 | ·22 | 4 | 33 | 9 | 6 | .. | |
| 1 5/16 .. | ·109 | 89·2 | 128,367 | ·23 | 4 | 14 | 8 | 28 | .. | |
| 1 3/8 .. | ·115 | 95·5 | 137,575 | ·25 | 3 | 58 | 7 | 56 | .. | |
| 1 7/16 .. | ·120 | 102 | 146,987 | ·27 | 3 | 42 | 7 | 24 | 11 | 6 |
| 1 1/2 .. | ·125 | 109 | 156,578 | ·28 | 3 | 28 | 6 | 56 | 10 | 24 |
| 1 9/16 .. | ·130 | 115·5 | 166,382 | ·30 | 3 | 16 | 6 | 32 | 9 | 48 |
| 1 5/8 .. | ·135 | 122·5 | 176,374 | ·32 | 3 | 5 | 6 | 10 | 9 | 15 |
| 1 11/16 .. | ·140 | 129·6 | 186,552 | ·34 | 2 | 55 | 5 | 50 | 8 | 45 |
| 1 3/4 .. | ·146 | 137 | 196,911 | ·36 | 2 | 45 | 5 | 30 | 8 | 15 |
| 1 13/16 .. | ·151 | 144 | 207,447 | ·38 | 2 | 37 | 5 | 14 | 7 | 51 |
| 1 7/8 .. | ·156 | 151·5 | 218,136 | ·40 | 2 | 30 | 5 | 0 | 7 | 30 |
| 1 15/16 .. | ·161 | 159 | 229,017 | ·42 | 2 | 22 | 4 | 44 | 7 | 6 |
| 2 .. | ·167 | 166·8 | 240,077 | ·44 | 2 | 16 | 4 | 32 | 6 | 48 |
| 2 1/16 .. | ·172 | 174·5 | 251,275 | ·46 | 2 | 10 | 4 | 20 | 6 | 30 |
| 2 1/8 .. | ·177 | 182·4 | 262,648 | ·48 | 2 | 4 | 4 | 8 | 6 | 12 |
| 2 3/16 .. | ·182 | 190·4 | 274,178 | ·50 | 1 | 58 | 3 | 56 | 5 | 54 |
| 2 1/4 .. | ·187 | 198·2 | 285,842 | ·52 | 1 | 54 | 3 | 48 | 5 | 42 |
| 2 5/16 .. | ·192 | 206·6 | 297,680 | ·54 | 1 | 50 | 3 | 40 | 5 | 30 |
| 2 3/8 .. | ·198 | 215 | 309,670 | ·56 | 1 | 46 | 3 | 32 | 5 | 18 |
| 2 7/16 .. | ·203 | 223·5 | 321,806 | ·59 | 1 | 42 | 3 | 24 | 5 | 6 |
| 2 1/2 .. | ·208 | 232·6 | 334,089 | ·61 | 1 | 38 | 3 | 16 | 4 | 54 |
| 2 9/16 .. | ·213 | 241 | 346,515 | ·63 | 1 | 34 | 3 | 8 | 4 | 42 |
| 2 5/8 .. | ·219 | 249·2 | 359,059 | ·66 | 1 | 30 | 3 | 0 | 4 | 30 |
| 2 11/16 .. | ·224 | 258 | 371,764 | ·68 | 1 | 27 | 2 | 54 | 4 | 21 |
| 2 3/4 .. | ·229 | 267·1 | 384,607 | ·71 | 1 | 24 | 2 | 48 | 4 | 12 |
| 2 13/16 .. | ·234 | 276 | 397,586 | ·73 | 1 | 22 | 2 | 44 | 4 | 6 |
| 2 7/8 .. | ·240 | 285 | 410,697 | ·75 | 1 | 20 | 2 | 40 | 4 | 0 |
| 2 15/16 .. | ·245 | 294·5 | 423,937 | ·78 | 1 | 18 | 2 | 36 | 3 | 54 |
| 3 .. | ·250 | 303·5 | 437,319 | ·80 | 1 | 15 | 2 | 30 | 3 | 45 |
| 3 1/16 .. | ·255 | 313 | 450,779 | ·83 | 1 | 12 | 2 | 24 | 3 | 36 |
| 3 1/8 .. | ·260 | 323 | 464,415 | ·85 | 1 | 10 | 2 | 20 | 3 | 30 |
| 3 3/16 .. | ·265 | 332 | 478,152 | ·88 | 1 | 8 | 2 | 16 | 3 | 24 |
| 3 1/4 .. | ·271 | 341·5 | 492,036 | ·90 | 1 | 6 | 2 | 12 | 3 | 18 |
| 3 5/16 .. | ·276 | 351·5 | 506,016 | ·93 | 1 | 4 | 2 | 8 | 3 | 12 |
| 3 3/8 .. | ·281 | 361 | 520,113 | ·95 | 1 | 2 | 2 | 4 | 3 | 6 |
| 3 7/16 .. | ·286 | 371 | 534,358 | ·98 | 1 | 1 | 2 | 2 | 3 | 3 |
| 3 1/2 .. | ·292 | 381 | 548,720 | 1·01 | 0 | 59 | 1 | 58 | 2 | 57 |
| 3 9/16 .. | ·297 | 391 | 563,169 | 1·03 | 0 | 58 | 1 | 56 | 2 | 54 |
| 3 5/8 .. | ·302 | 401 | 577,731 | 1·06 | 0 | 57 | 1 | 54 | 2 | 51 |
| 3 11/16 .. | ·307 | 411·5 | 592,436 | 1·09 | 0 | 55 | 1 | 50 | 2 | 45 |
| 3 3/4 .. | ·312 | 421·5 | 607,253 | 1·12 | 0 | 54 | 1 | 48 | 2 | 42 |
| 3 13/16 .. | ·318 | 432 | 622,149 | 1·14 | 0 | 53 | 1 | 46 | 2 | 39 |
| 3 7/8 .. | ·323 | 442·5 | 637,186 | 1·17 | 0 | 51 | 1 | 42 | 2 | 33 |
| 3 15/16 .. | ·328 | 453 | 652,268 | 1·20 | 0 | 50 | 1 | 40 | 2 | 30 |
| 4 .. | ·333 | 463·5 | 667,520 | 1·23 | 0 | 49 | 1 | 38 | 2 | 27 |
| 4 1/16 .. | ·338 | 474 | 682,878 | 1·26 | 0 | 48 | 1 | 36 | 2 | 24 |
| 4 1/8 .. | ·344 | 485 | 698,304 | 1·28 | 0 | 47 | 1 | 34 | 2 | 21 |
| 4 3/16 .. | ·349 | 496 | 713,869 | 1·31 | 0 | 46 | 1 | 32 | 2 | 18 |
| 4 1/4 .. | ·355 | 506·5 | 729,500 | 1·34 | 0 | 45 | 1 | 30 | 2 | 15 |
| 4 5/16 .. | ·360 | 517·5 | 745,239 | 1·37 | 0 | 44 | 1 | 28 | 2 | 12 |
| 4 3/8 .. | ·365 | 528·5 | 761,109 | 1·40 | 0 | 43 | 1 | 26 | 2 | 9 |
| 4 7/16 .. | ·370 | 539·5 | 777,038 | 1·43 | 0 | 42 | 1 | 24 | 2 | 6 |
| 4 1/2 .. | ·375 | 551 | 793,105 | 1·46 | 0 | 41 | 1 | 22 | 2 | 3 |
| 4 9/16 .. | ·380 | 562 | 809,228 | 1·49 | 0 | 40 | 1 | 20 | 2 | 0 |
| 4 5/8 .. | ·385 | 573 | 825,489 | 1·52 | 0 | 39 | 1 | 18 | 1 | 57 |
| 4 11/16 .. | ·390 | 584·5 | 841,770 | 1·55 | 0 | 38·7 | 1 | 17·4 | 1 | 56 |
| 4 3/4 .. | ·396 | 596 | 858,220 | 1·58 | 0 | 38 | 1 | 16 | 1 | 54 |
| 4 13/16 .. | ·401 | 607·5 | 874,764 | 1·61 | 0 | 37 | 1 | 14 | 1 | 51 |
| 4 7/8 .. | ·406 | 619 | 891,354 | 1·64 | 0 | 36·5 | 1 | 13 | 1 | 49 |
| 4 15/16 .. | ·411 | 631 | 908,082 | 1·67 | 0 | 35·7 | 1 | 11·4 | 1 | 47 |
| 5 .. | ·417 | 642 | 924,854 | 1·70 | 0 | 35·2 | 1 | 10·4 | 1 | 45·6 |
| 5 1/16 .. | ·422 | 654 | 941,729 | 1·73 | 0 | 34·6 | 1 | 9·2 | 1 | 43·8 |
| 5 1/8 .. | ·427 | 666 | 958,667 | 1·76 | 0 | 34 | 1 | 8 | 1 | 42 |
| 5 3/16 .. | ·432 | 678 | 975,763 | 1·79 | 0 | 33·3 | 1 | 6·6 | 1 | 39·9 |

TABLE VIII.—*continued.*

WEIR MEASUREMENT TABLE FOR WEIR 2 FEET WIDE (BY FRANCIS FORMULÆ)—*continued.*

| Depth of Water over Lip of Weir. From Still Water. | | Discharge. | | | Time Required to Pump Acre Inches as below. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Gallons per Minute. | Gallons per Day. | Acre Inches per Hour. | 4 | | 5 | | 6 | |
| Inches. | Feet. | | | | Hrs. | Mins. | Hrs. | Mins. | Hrs. | Mins. |
| 1 .. | ·083 | 59·4 | 85,564 | ·16 | .. | | .. | | .. | |
| 1 1/16 .. | ·088 | 65·1 | 93,696 | ·17 | .. | | .. | | .. | |
| 1 1/8 .. | ·094 | 70·9 | 102,030 | ·19 | .. | | .. | | .. | |
| 1 3/16 .. | ·099 | 76·8 | 110,592 | ·20 | .. | | .. | | .. | |
| 1 1/4 .. | ·104 | 82·9 | 119,367 | ·22 | .. | | .. | | .. | |
| 1 5/16 .. | ·109 | 89·2 | 128,367 | ·23 | .. | | .. | | .. | |
| 1 3/8 .. | ·115 | 95·5 | 137,575 | ·25 | .. | | .. | | .. | |
| 1 7/16 .. | ·120 | 102 | 146,987 | ·27 | .. | | .. | | .. | |
| 1 1/2 .. | ·125 | 109 | 156,578 | ·28 | .. | | .. | | .. | |
| 1 9/16 .. | ·130 | 115·5 | 166,382 | ·30 | .. | | .. | | .. | |
| 1 5/8 .. | ·135 | 122·5 | 176,374 | ·32 | .. | | .. | | .. | |
| 1 11/16 .. | ·140 | 129·6 | 186,552 | ·34 | .. | | .. | | .. | |
| 1 3/4 .. | ·146 | 137 | 196,911 | ·36 | .. | | .. | | .. | |
| 1 13/16 .. | ·151 | 144 | 207,447 | ·38 | .. | | .. | | .. | |
| 1 7/8 .. | ·156 | 151·5 | 218,136 | ·40 | 10 | 0 | .. | | .. | |
| 1 15/16 .. | ·161 | 159 | 229,017 | ·42 | 9 | 28 | .. | | .. | |
| 2 .. | ·167 | 166·8 | 240,077 | ·44 | 9 | 4 | .. | | .. | |
| 2 1/16 .. | ·172 | 174·5 | 251,275 | ·46 | 8 | 40 | .. | | .. | |
| 2 1/8 .. | ·177 | 182·4 | 262,648 | ·48 | 8 | 16 | 10 | 20 | .. | |
| 2 3/16 .. | ·182 | 190·4 | 274,178 | ·50 | 7 | 52 | 9 | 50 | .. | |
| 2 1/4 .. | ·187 | 198·2 | 285,842 | ·52 | 7 | 36 | 9 | 30 | .. | |
| 2 5/16 .. | ·192 | 206·6 | 297,680 | ·54 | 7 | 20 | 9 | 10 | .. | |
| 2 3/8 .. | ·198 | 215 | 309,670 | ·56 | 7 | 4 | 8 | 50 | .. | |
| 2 7/16 .. | ·203 | 223·5 | 321,806 | ·59 | 6 | 48 | 8 | 30 | 10 | 12 |
| 2 1/2 .. | ·208 | 232·6 | 334,089 | ·61 | 6 | 32 | 8 | 10 | 9 | 48 |
| 2 9/16 .. | ·213 | 241 | 346,515 | ·63 | 6 | 16 | 7 | 50 | 9 | 22 |
| 2 5/8 .. | ·219 | 249·2 | 359,059 | ·66 | 6 | 0 | 7 | 30 | 9 | 0 |
| 2 11/16 .. | ·224 | 258 | 371,764 | ·68 | 5 | 48 | 7 | 15 | 8 | 42 |
| 2 3/4 .. | ·229 | 267·1 | 384,607 | ·71 | 5 | 36 | 7 | 0 | 8 | 24 |
| 2 13/16 .. | ·234 | 276 | 397,586 | ·73 | 5 | 28 | 6 | 50 | 8 | 12 |
| 2 7/8 .. | ·240 | 285 | 410,697 | ·75 | 5 | 20 | 6 | 40 | 8 | 0 |
| 2 15/16 .. | ·245 | 294·5 | 423,937 | ·78 | 5 | 12 | 6 | 30 | 7 | 48 |
| 3 .. | ·250 | 303·5 | 437,319 | ·80 | 5 | 0 | 6 | 15 | 7 | 30 |
| 3 1/16 .. | ·255 | 313 | 450,779 | ·83 | 4 | 48 | 6 | 0 | 7 | 12 |
| 3 1/8 .. | ·260 | 323 | 464,415 | ·85 | 4 | 40 | 5 | 50 | 7 | 0 |
| 3 3/16 .. | ·265 | 332 | 478,152 | ·88 | 4 | 32 | 5 | 40 | 6 | 48 |
| 3 1/4 .. | ·271 | 341·5 | 492,036 | ·90 | 4 | 24 | 5 | 30 | 6 | 36 |
| 3 5/16 .. | ·276 | 351·5 | 506,016 | ·93 | 4 | 16 | 5 | 20 | 6 | 24 |
| 3 3/8 .. | ·281 | 361 | 520,113 | ·95 | 4 | 8 | 5 | 10 | 6 | 12 |
| 3 7/16 | ·286 | 371 | 534,358 | ·98 | 4 | 4 | 5 | 5 | 6 | 6 |
| 3 1/2 .. | ·292 | 381 | 548,720 | 1·01 | 3 | 56 | 4 | 55 | 5 | 54 |
| 3 9/16 .. | ·297 | 391 | 563,169 | 1·03 | 3 | 52 | 4 | 50 | 5 | 48 |
| 3 5/8 .. | ·302 | 401 | 577,731 | 1·06 | 3 | 45 | 4 | 45 | 5 | 42 |
| 3 11/16 .. | ·307 | 411·5 | 592,436 | 1·09 | 3 | 40 | 4 | 35 | 5 | 30 |
| 3 3/4 .. | ·312 | 421·5 | 607,253 | 1·12 | 3 | 36 | 4 | 30 | 5 | 22 |
| 3 13/16 .. | ·318 | 432 | 622,149 | 1·14 | 3 | 32 | 4 | 25 | 5 | 18 |
| 3 7/8 .. | ·323 | 442·5 | 637,186 | 1·17 | 3 | 24 | 4 | 15 | 5 | 6 |
| 3 15/16 .. | ·328 | 453 | 652,268 | 1·20 | 3 | 20 | 4 | 10 | 5 | 0 |
| 4 .. | ·333 | 463·5 | 667,520 | 1·23 | 3 | 16 | 4 | 5 | 4 | 54 |
| 4 1/16 .. | ·338 | 474 | 682,878 | 1·26 | 3 | 12 | 4 | 0 | 4 | 48 |
| 4 1/8 .. | ·344 | 485 | 698,304 | 1·28 | 3 | 8 | 3 | 55 | 4 | 42 |
| 4 3/16 .. | ·349 | 496 | 713,869 | 1·31 | 3 | 4 | 3 | 50 | 4 | 36 |
| 4 1/4 .. | ·355 | 506·5 | 729,500 | 1·34 | 3 | 0 | 3 | 45 | 4 | 30 |
| 4 5/16 .. | ·360 | 517·5 | 745,239 | 1·37 | 2 | 56 | 3 | 40 | 4 | 24 |
| 4 3/8 .. | ·365 | 528·5 | 761,109 | 1·40 | 2 | 52 | 3 | 35 | 4 | 18 |
| 4 7/16 .. | ·370 | 539·5 | 777,038 | 1·43 | 2 | 48 | 3 | 30 | 4 | 12 |
| 4 1/2 .. | ·375 | 551 | 793,105 | 1·46 | 2 | 44 | 3 | 25 | 4 | 6 |
| 4 9/16 .. | ·380 | 562 | 809,228 | 1·49 | 2 | 40 | 3 | 20 | 4 | 0 |
| 4 5/8 .. | ·385 | 573 | 825,489 | 1·52 | 2 | 36 | 3 | 15 | 3 | 54 |
| 4 11/16 .. | ·390 | 584·5 | 841,770 | 1·55 | 2 | 34 | 3 | 13 | 3 | 52 |
| 4 3/4 .. | ·396 | 596 | 858,220 | 1·58 | 2 | 32 | 3 | 10 | 3 | 48 |
| 4 13/16 .. | ·401 | 607·5 | 874,764 | 1·61 | 2 | 28 | 3 | 5 | 3 | 42 |
| 4 7/8 .. | ·406 | 619 | 891,354 | 1·64 | 2 | 26 | 3 | 2 | 3 | 38 |
| 4 15/16 .. | ·411 | 631 | 908,082 | 1·67 | 2 | 22 | 3 | 0 | 3 | 34 |
| 5 .. | ·417 | 642 | 924,854 | 1·70 | 2 | 20 | 2 | 56 | 3 | 31 |
| 5 1/16 .. | ·422 | 654 | 941,729 | 1·73 | 2 | 18 | 2 | 53 | 3 | 28 |
| 5 1/8 .. | ·427 | 666 | 958,667 | 1·76 | 2 | 16 | 2 | 50 | 3 | 24 |
| 5 3/16 .. | ·432 | 678 | 975,763 | 1·79 | 2 | 13 | 2 | 46 | 3 | 20 |

TABLE VIII.—*continued.*

WEIR MEASUREMENT TABLE FOR WEIR 2 FEET WIDE (BY FRANCIS FORMULÆ)—*continued.*

| Depth of Water over Lip of Weir. From Still Water. | | Discharge. | | | Time Required to Pump Acre Inches as below. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Gallons per Minute. | Gallons per Day. | Acre Inches per Hour. | 1 | | 2 | | 3 | |
| Inches. | Feet. | | | | Hrs. Mins. | | Hrs. Mins. | | Hrs. Mins. | |
| 5 1/4 .. | ·437 | 689·5 | 992,937 | 1·82 | 0 | 32·8 | 1 | 5·6 | 1 | 38·4 |
| 5 5/16 .. | ·443 | 701·5 | 1,010,145 | 1·86 | 0 | 32·2 | 1 | 4·4 | 1 | 36·6 |
| 5 3/8 .. | ·448 | 713 | 1,027,491 | 1·89 | 0 | 31·7 | 1 | 3·4 | 1 | 35·1 |
| 5 7/16 .. | ·453 | 725 | 1,044,834 | 1·92 | 0 | 31·2 | 1 | 2·4 | 1 | 33·6 |
| 5 1/2 .. | ·458 | 738 | 1,062,349 | 1·96 | 0 | 30·6 | 1 | 1·2 | 1 | 31·8 |
| 5 9/16 .. | ·463 | 749·5 | 1,079,950 | 1·99 | 0 | 32·2 | 1 | 0·4 | 1 | 30·6 |
| 5 5/8 .. | ·469 | 763 | 1,097,573 | 2·02 | 0 | 29·6 | 0 | 59·2 | 1 | 28·8 |
| 5 11/16 .. | ·474 | 775 | 1,115,343 | 2·05 | 0 | 29·2 | 0 | 58·4 | 1 | 27·6 |
| 5 3/4 .. | ·479 | 787 | 1,133,124 | 2·08 | 0 | 28·7 | 0 | 57·4 | 1 | 26·1 |
| 5 13/16 .. | ·484 | 799 | 1,151,015 | 2·12 | 0 | 28·3 | 0 | 56·6 | 1 | 24·9 |
| 5 7/8 .. | ·489 | 812 | 1,168,958 | 2·15 | 0 | 27·8 | 0 | 55·6 | 1 | 23·4 |
| 5 15/16 .. | ·495 | 824·5 | 1,187,043 | 2·18 | 0 | 27·4 | 0 | 54·8 | 1 | 22·2 |
| 6 .. | ·500 | 837 | 1,205,210 | 2·22 | 0 | 27 | 0 | 54 | 1 | 21 |
| 6 1/16 .. | ·505 | 850 | 1,223,349 | 2·25 | 0 | 26·6 | 0 | 53·2 | 1 | 19·8 |
| 6 1/8 .. | ·510 | 862 | 1,241,625 | 2·28 | 0 | 26·2 | 0 | 52·4 | 1 | 18·6 |
| 6 3/16 .. | ·516 | 875 | 1,259,997 | 2·32 | 0 | 25·8 | 0 | 51·6 | 1 | 17·4 |
| 6 1/4 .. | ·521 | 888 | 1,278,467 | 2·35 | 0 | 25·4 | 0 | 50·8 | 1 | 16·2 |
| 6 5/16 .. | ·526 | 901 | 1,296,909 | 2·39 | 0 | 25·1 | 0 | 50·2 | 1 | 15·3 |
| 6 3/8 .. | ·531 | 914 | 1,315,529 | 2·42 | 0 | 24·7 | 0 | 49·4 | 1 | 14·1 |
| 6 7/16 .. | ·536 | 927 | 1,334,225 | 2·46 | 0 | 24·4 | 0 | 48·8 | 1 | 13·2 |
| 6 1/2 .. | ·542 | 940 | 1,352,922 | 2·49 | 0 | 24 | 0 | 48 | 1 | 12 |
| 6 9/16 .. | ·547 | 953 | 1,371,765 | 2·52 | 0 | 23·7 | 0 | 47·4 | 1 | 11·1 |
| 6 5/8 .. | ·552 | 966 | 1,390,603 | 2·56 | 0 | 23·4 | 0 | 46·8 | 1 | 10·2 |
| 6 11/16 .. | ·557 | 979 | 1,409,550 | 2·60 | 0 | 23·1 | 0 | 46·2 | 1 | 9·3 |
| 6 3/4 .. | ·562 | 992 | 1,428,602 | 2·63 | 0 | 22·8 | 0 | 45·6 | 1 | 8·4 |
| 6 13/16 .. | ·568 | 1,005 | 1,447,656 | 2·66 | 0 | 22·5 | 0 | 45 | 1 | 7·5 |
| 6 7/8 .. | ·573 | 1,018 | 1,466,856 | 2·70 | 0 | 22·2 | 0 | 44·4 | 1 | 6·6 |
| 6 15/16 .. | ·578 | 1,032 | 1,486,032 | 2·74 | 0 | 21·9 | 0 | 43·8 | 1 | 5·7 |
| 7 .. | ·583 | 1,045 | 1,505,370 | 2·77 | 0 | 21·6 | 0 | 43·2 | 1 | 4·8 |
| 7 1/16 .. | ·588 | 1,059 | 1,524,656 | 2·81 | 0 | 21·3 | 0 | 42·6 | 1 | 3·9 |
| 7 1/8 .. | ·594 | 1,072 | 1,544,126 | 2·84 | 0 | 21·1 | 0 | 42·2 | 1 | 3·3 |
| 7 3/16 .. | ·599 | 1,086 | 1,563,667 | 2·88 | 0 | 20·8 | 0 | 41·6 | 1 | 2·4 |
| 7 1/4 .. | ·604 | 1,100 | 1,583,183 | 2·92 | 0 | 20·5 | 0 | 41 | 1 | 1·5 |
| 7 5/16 .. | ·609 | 1,113 | 1,602,853 | 2·95 | 0 | 20·3 | 0 | 40·6 | 1 | 0·9 |
| 7 3/8 .. | ·614 | 1,127 | 1,622,502 | 2·99 | 0 | 20 | 0 | 40 | 1 | 0 |
| 7 7/16 .. | ·620 | 1,140 | 1,642,262 | 3·02 | 0 | 19·8 | 0 | 39·6 | 0 | 59·4 |
| 7 1/2 .. | ·625 | 1,154 | 1,662,167 | 3·06 | 0 | 19·6 | 0 | 39·2 | 0 | 58·8 |
| 7 9/16 .. | ·630 | 1,168 | 1,681,966 | 3·09 | 0 | 19·3 | 0 | 38·6 | 0 | 57·9 |
| 7 5/8 .. | ·635 | 1,182 | 1,701,958 | 3·13 | 0 | 19·1 | 0 | 38·2 | 0 | 57·3 |
| 7 11/16 .. | ·641 | 1,196 | 1,721,922 | 3·17 | 0 | 18·9 | 0 | 37·8 | 0 | 56·7 |
| 7 3/4 .. | ·646 | 1,210 | 1,742,039 | 3·21 | 0 | 18·7 | 0 | 37·4 | 0 | 56·1 |
| 7 13/16 .. | ·651 | 1,224 | 1,762,084 | 3·24 | 0 | 18·5 | 0 | 37 | 0 | 55·5 |
| 7 7/8 .. | ·656 | 1,238 | 1,782,324 | 3·28 | 0 | 18·2 | 0 | 36·4 | 0 | 54·6 |
| 7 15/16 .. | ·661 | 1,252 | 1,802,530 | 3·32 | 0 | 18 | 0 | 36 | 0 | 54 |
| 8 .. | ·666 | 1,266 | 1,822,893 | 3·36 | 0 | 17·8 | 0 | 35·6 | 0 | 53·4 |
| 8 1/16 .. | ·672 | 1,280 | 1,843,315 | 3·39 | 0 | 17·6 | 0 | 35·2 | 0 | 52·8 |
| 8 1/8 .. | ·677 | 1,294 | 1,863,698 | 3·43 | 0 | 17·4 | 0 | 34·8 | 0 | 52·2 |
| 8 3/16 .. | ·682 | 1,308 | 1,884,197 | 3·47 | 0 | 17·3 | 0 | 34·6 | 0 | 51·9 |
| 8 1/4 .. | ·687 | 1,322 | 1,904,697 | 3·50 | 0 | 17·1 | 0 | 34·2 | 0 | 51·3 |
| 8 5/16 .. | ·693 | 1,337 | 1,925,354 | 3·54 | 0 | 16·9 | 0 | 33·8 | 0 | 50·7 |
| 8 3/8 .. | ·698 | 1,352 | 1,946,070 | 3·58 | 0 | 16·7 | 0 | 33·4 | 0 | 50·1 |
| 8 7/16 .. | ·703 | 1,366 | 1,966,740 | 3·62 | 0 | 16·5 | 0 | 33 | 0 | 49·5 |
| 8 1/2 .. | ·708 | 1,380 | 1,987,570 | 3·66 | 0 | 16·4 | 0 | 32·8 | 0 | 49·2 |
| 8 9/16 .. | ·713 | 1,395 | 2,008,307 | 3·70 | 0 | 16·2 | 0 | 32·4 | 0 | 48·6 |
| 8 5/8 .. | ·719 | 1,409 | 2,029,250 | 3·73 | 0 | 16 | 0 | 32 | 0 | 48 |
| 8 11/16 .. | ·724 | 1,424 | 2,050,140 | 3·77 | 0 | 15·8 | 0 | 31·6 | 0 | 47·4 |
| 8 3/4 .. | ·729 | 1,439 | 2,071,193 | 3·81 | 0 | 15·7 | 0 | 31·4 | 0 | 47·1 |
| 8 13/16 .. | ·734 | 1,453 | 2,092,302 | 3·85 | 0 | 15·5 | 0 | 31 | 0 | 46·5 |
| 8 7/8 .. | ·739 | 1,468 | 2,113,352 | 3·89 | 0 | 15·4 | 0 | 30·8 | 0 | 46·2 |
| 8 15/16 .. | ·744 | 1,482 | 2,134,526 | 3·93 | 0 | 15·2 | 0 | 30·4 | 0 | 45·6 |
| 9 .. | ·750 | 1,497 | 2,155,841 | 3·97 | 0 | 15 | 0 | 30 | 0 | 45 |
| 9 1/16 .. | ·755 | 1,512 | 2,177,005 | 4·01 | 0 | 14·9 | 0 | 29·8 | 0 | 44·7 |
| 9 1/8 .. | ·760 | 1,526 | 2,198,263 | 4·04 | 0 | 14·7 | 0 | 29·4 | 0 | 44·1 |
| 9 3/16 .. | ·766 | 1,542 | 2,219,694 | 4·09 | 0 | 14·6 | 0 | 29·2 | 0 | 43·8 |
| 9 1/4 .. | ·771 | 1,557 | 2,241,175 | 4·13 | 0 | 14·5 | 0 | 29 | 0 | 43·5 |
| 9 5/16 .. | ·776 | 1,571 | 2,262,542 | 4·16 | 0 | 14·4 | 0 | 28·8 | 0 | 43·2 |
| 9 3/8 .. | ·781 | 1,586 | 2,284,127 | 4·20 | 0 | 14·2 | 0 | 28·4 | 0 | 42·6 |
| 9 7/16 .. | ·786 | 1,601 | 2,305,637 | 4·24 | 0 | 14·1 | 0 | 28·2 | 0 | 42·3 |

TABLE VIII.—*continued.*

WEIR MEASUREMENT TABLE FOR WEIR 2 FEET WIDE (BY FRANCIS FORMULÆ)—*continued.*

| Depth of Water over Lip of Weir. From Still Water. | | Discharge. | | | Time Required to Pump Acre Inches as Below. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Gallons per Minute. | Gallons per Day. | Acre Inches per Hour. | 4 | | 5 | | 6 | |
| Inches. | Feet. | | | | Hrs. | Mins. | Hrs. | Mins. | Hrs. | Mins. |
| 5 1/4 | ·437 | 689·5 | 992,937 | 1·82 | 2 | 11 | 2 | 44 | 3 | 16 |
| 5 5/16 | ·443 | 701·5 | 1,010,145 | 1·86 | 2 | 9 | 2 | 41 | 3 | 13 |
| 5 3/8 | ·448 | 713 | 1,027,491 | 1·89 | 2 | 7 | 2 | 39 | 3 | 10 |
| 5 7/16 | ·453 | 725 | 1,044,834 | 1·92 | 2 | 5 | 2 | 36 | 3 | 7 |
| 5 1/2 | ·458 | 738 | 1,062,349 | 1·96 | 2 | 2 | 2 | 33 | 3 | 4 |
| 5 9/16 | ·463 | 749·5 | 1,079,950 | 1·99 | 2 | 1 | 2 | 31 | 3 | 1 |
| 5 5/8 | ·469 | 763 | 1,097,573 | 2·02 | 1 | 58 | 2 | 28 | 2 | 57 |
| 5 11/16 | ·474 | 775 | 1,115,343 | 2·05 | 1 | 56 | 2 | 26 | 2 | 55 |
| 5 3/4 | ·479 | 787 | 1,133,124 | 2·08 | 1 | 54 | 2 | 23 | 2 | 52 |
| 5 13/16 | ·484 | 799 | 1,151,015 | 2·12 | 1 | 53 | 2 | 21 | 2 | 49 |
| 5 7/8 | ·489 | 812 | 1,168,958 | 2·15 | 1 | 51 | 2 | 19 | 2 | 46 |
| 5 15/16 | ·495 | 824·5 | 1,187,043 | 2·18 | 1 | 49 | 2 | 17 | 2 | 44 |
| 6 | ·500 | 837 | 1,205,210 | 2·22 | 1 | 48 | 2 | 15 | 2 | 42 |
| 6 1/16 | ·505 | 850 | 1,223,349 | 2·25 | 1 | 46 | 2 | 13 | 2 | 39 |
| 6 1/8 | ·510 | 862 | 1,241,625 | 2·28 | 1 | 44 | 2 | 11 | 2 | 37 |
| 6 3/16 | ·516 | 875 | 1,259,997 | 2·32 | 1 | 43 | 2 | 9 | 2 | 35 |
| 6 1/4 | ·521 | 888 | 1,278,467 | 2·35 | 1 | 41 | 2 | 7 | 2 | 32 |
| 6 5/16 | ·526 | 901 | 1,296,909 | 2·39 | 1 | 40 | 2 | 5 | 2 | 30 |
| 6 3/8 | ·531 | 914 | 1,315,529 | 2·42 | 1 | 39 | 2 | 3 | 2 | 28 |
| 6 7/16 | ·536 | 927 | 1,334.225 | 2·46 | 1 | 37 | 2 | 2 | 2 | 26 |
| 6 1/2 | ·542 | 940 | 1,352,922 | 2·49 | 1 | 36 | 2 | 0 | 2 | 24 |
| 6 9/16 | ·547 | 953 | 1,371,765 | 2·52 | 1 | 34 | 1 | 58 | 2 | 22 |
| 6 5/8 | ·552 | 966 | 1,390,603 | 2·56 | 1 | 33 | 1 | 57 | 2 | 20 |
| 6 11/16 | ·557 | 979 | 1,409,550 | 2·60 | 1 | 32 | 1 | 55 | 2 | 18 |
| 6 3/4 | ·562 | 992 | 1,428,602 | 2·63 | 1 | 31 | 1 | 54 | 2 | 17 |
| 6 13/16 | ·568 | 1,005 | 1,447,656 | 2·66 | 1 | 30 | 1 | 52 | 2 | 15 |
| 6 7/8 | ·573 | 1,018 | 1,466,856 | 2·70 | 1 | 28 | 1 | 51 | 2 | 13 |
| 6 15/16 | ·578 | 1,032 | 1,486,032 | 2·74 | 1 | 27 | 1 | 49 | 2 | 11 |
| 7 | ·583 | 1,045 | 1,505,370 | 2·77 | 1 | 26 | 1 | 48 | 2 | 9 |
| 7 1/16 | ·588 | 1,059 | 1,524,656 | 2·81 | 1 | 25 | 1 | 46 | 2 | 7 |
| 7 1/8 | ·594 | 1,072 | 1,544,126 | 2·84 | 1 | 24 | 1 | 45 | 2 | 6 |
| 6 3/16 | ·599 | 1,086 | 1,563,667 | 2·88 | 1 | 23 | 1 | 44 | 2 | 5 |
| 7 1/4 | ·604 | 1,100 | 1,583,183 | 2·92 | 1 | 22 | 1 | 42 | 2 | 3 |
| 7 5/16 | ·609 | 1,113 | 1,602,853 | 2·95 | 1 | 21 | 1 | 41 | 2 | 1 |
| 7 3/8 | ·614 | 1,127 | 1,622,502 | 2·99 | 1 | 20 | 1 | 40 | 2 | 0 |
| 7 7/16 | ·620 | 1,140 | 1,642,262 | 3·02 | 1 | 19 | 1 | 39 | 1 | 59 |
| 7 1/2 | ·625 | 1,154 | 1,662,167 | 3·06 | 1 | 18 | 1 | 37 | 1 | 57 |
| 7 9/16 | ·630 | 1,168 | 1,681,966 | 3·09 | 1 | 17 | 1 | 36 | 1 | 56 |
| 7 5/8 | ·635 | 1,182 | 1,701,958 | 3·13 | 1 | 16 | 1 | 35 | 1 | 55 |
| 7 11/16 | ·641 | 1,196 | 1,721,922 | 3·17 | 1 | 15 | 1 | 34 | 1 | 53 |
| 7 3/4 | ·646 | 1,210 | 1,742,039 | 3·21 | 1 | 15 | 1 | 33 | 1 | 52 |
| 7 13/16 | ·651 | 1,224 | 1,762,084 | 3·24 | 1 | 14 | 1 | 32 | 1 | 51 |
| 7 7/8 | ·656 | 1,238 | 1,782,324 | 3·28 | 1 | 13 | 1 | 31 | 1 | 49 |
| 7 15/16 | ·661 | 1,252 | 1,802,530 | 3·32 | 1 | 12 | 1 | 30 | 1 | 48 |
| 8 | ·666 | 1,266 | 1,822,893 | 3·36 | 1 | 11 | 1 | 29 | 1 | 46 |
| 8 1/16 | ·672 | 1,280 | 1,843,315 | 3·39 | 1 | 10 | 1 | 28 | 1 | 45 |
| 8 1/8 | ·677 | 1,294 | 1,863,698 | 3·43 | 1 | 9 | 1 | 27 | 1 | 44 |
| 8 3/16 | ·682 | 1,308 | 1,884,197 | 3·47 | 1 | 9 | 1 | 26 | 1 | 44 |
| 8 1/4 | ·687 | 1,322 | 1,904,697 | 3·50 | 1 | 8 | 1 | 25 | 1 | 43 |
| 8 5/16 | ·693 | 1,337 | 1,925,354 | 3·54 | 1 | 7 | 1 | 24 | 1 | 42 |
| 8 3/8 | ·698 | 1,352 | 1,946,070 | 3·58 | 1 | 7 | 1 | 23 | 1 | 41 |
| 8 7/16 | ·703 | 1,366 | 1,966,740 | 3·62 | 1 | 6 | 1 | 22 | 1 | 40 |
| 8 1/2 | ·708 | 1,380 | 1,987,570 | 3·66 | 1 | 6 | 1 | 22 | 1 | 39 |
| 8 9/16 | ·713 | 1,395 | 2,008,307 | 3·70 | 1 | 5 | 1 | 21 | 1 | 38 |
| 8 5/8 | ·719 | 1,409 | 2,029,250 | 3·73 | 1 | 4 | 1 | 20 | 1 | 37 |
| 8 11/16 | ·724 | 1,424 | 2,050,140 | 3·77 | 1 | 3 | 1 | 19 | 1 | 36 |
| 8 3/4 | ·729 | 1,439 | 2,071,193 | 3·81 | 1 | 2·8 | 1 | 18·5 | 1 | 34 |
| 8 13/16 | ·734 | 1,453 | 2,092,302 | 3·85 | 1 | 2 | 1 | 16·5 | 1 | 35 |
| 8 7/8 | ·739 | 1,468 | 2,113,352 | 3·89 | 1 | 1·6 | 1 | 16·2 | 1 | 32 |
| 8 15/16 | ·744 | 1,482 | 2,134,526 | 3·93 | 1 | 0·4 | 1 | 16 | 1 | 31 |
| 9 | ·750 | 1,497 | 2,155,841 | 3·97 | 1 | 0 | 1 | 15 | 1 | 30 |
| 9 1/16 | ·755 | 1,512 | 2,177,005 | 4·01 | 0 | 59·6 | 1 | 14·5 | 1 | 29 |
| 9 1/8 | ·760 | 1,526 | 2,198,263 | 4·04 | 0 | 58·8 | 1 | 13·5 | 1 | 28 |
| 9 3/16 | ·766 | 1,542 | 2,219,694 | 4·09 | 0 | 58·4 | 1 | 13 | 1 | 27 |
| 9 1/4 | ·771 | 1,557 | 2,241,175 | 4·13 | 0 | 58 | 1 | 12·5 | 1 | 27 |
| 9 5/16 | ·776 | 1,571 | 2,262,542 | 4·16 | 0 | 57·6 | 1 | 12 | 1 | 26 |
| 9 3/8 | ·781 | 1,586 | 2,284,127 | 4·20 | 0 | 56·8 | 1 | 11 | 1 | 25 |
| 9 7/16 | ·786 | 1,601 | 2,305,637 | 4·24 | 0 | 56·4 | 1 | 10·5 | 1 | 24 |

## TABLE X.

FLOW OF WATER IN CHANNELS.

| FALL OF DITCH. | | T—2 ft. 4 in.; B—1 ft.; D—4 ft. | | | T—3 ft.; B—1 ft.; D—6 in. | | |
|---|---|---|---|---|---|---|---|
| Feet per Mile. | Inches per Chain. | Velocity—Feet per Second. | Gallons per Minute. | Acre Inches per Hour. | Velocity—Feet per Second. | Gallons per Minute. | Acre Inches per Hour. |
| ·5 | ·075 | ·14 | 29 | ·08 | ·19 | 69 | ·19 |
| 1·0 | ·150 | ·21 | 44 | ·12 | ·28 | 104 | ·27 |
| 1·5 | ·225 | ·26 | 55 | ·15 | ·35 | 131 | ·35 |
| 2·0 | ·330 | ·31 | 64 | ·18 | ·41 | 154 | ·41 |
| 2·5 | ·375 | ·35 | 73 | ·20 | ·46 | 173 | ·46 |
| 3·0 | ·450 | ·39 | 80 | ·22 | ·51 | 191 | ·50 |
| 3·5 | ·525 | ·42 | 86 | ·23 | ·55 | 207 | ·54 |
| 4·0 | ·600 | ·45 | 93 | ·25 | 59 | 222 | ·59 |
| 4·5 | ·675 | ·48 | 99 | ·27 | ·63 | 236 | ·62 |
| 5·0 | ·750 | ·51 | 105 | ·28 | ·67 | 249 | ·66 |
| 5·5 | ·825 | ·53 | 110 | ·29 | ·70 | 262 | ·69 |
| 6·0 | ·900 | ·56 | 115 | ·30 | ·73 | 274 | ·73 |
| 6·5 | ·975 | ·58 | 120 | ·32 | ·76 | 286 | ·75 |
| 7·0 | 1·050 | ·60 | 124 | ·33 | ·79 | 297 | ·78 |
| 7·5 | 1·125 | ·62 | 129 | ·34 | ·82 | 308 | ·81 |
| 8·0 | 1·200 | ·64 | 134 | ·36 | ·85 | 318 | ·84 |
| 8·5 | 1·275 | ·66 | 138 | ·37 | ·88 | 328 | ·87 |
| 9·0 | 1·350 | ·68 | 142 | ·38 | ·90 | 338 | ·89 |
| 9·5 | 1·425 | ·70 | 146 | ·39 | ·93 | 347 | ·92 |
| 10·0 | 1·500 | ·72 | 150 | ·40 | ·95 | 356 | ·94 |

(Table IX. was published in the Text—Ed.)

| FALL OF DITCH. | | T—3 ft. 4 in.; B—1 ft.; D—7 inches. | | | T—3 ft. 8 in.; B—1 ft.; D—8 inches. | | |
|---|---|---|---|---|---|---|---|
| Feet per Mile. | Inches per Chain. | Velocity. | Gallons per Minute. | Acre inches per Hour. | Velocity. | Gallons per Minute. | Acre inches per hour. |
| ·5 | ·075 | ·21 | 97 | ·26 | ·23 | 132 | ·35 |
| 1·0 | ·150 | ·31 | 147 | ·39 | ·34 | 198 | ·52 |
| 1·5 | ·225 | ·39 | 184 | ·49 | ·43 | 249 | ·66 |
| 2·0 | ·330 | ·46 | 216 | ·56 | ·50 | 291 | ·77 |
| 2·5 | ·375 | ·51 | 243 | ·64 | ·56 | 328 | ·87 |
| 3·0 | ·450 | ·57 | 268 | ·71 | ·62 | 361 | ·95 |
| 3·5 | ·525 | ·61 | 290 | ·77 | ·67 | 392 | 1·03 |
| 4·0 | ·600 | ·66 | 312 | ·83 | ·72 | 420 | 1·12 |
| 4·5 | ·675 | ·70 | 331 | ·88 | ·77 | 447 | 1·18 |
| 5·0 | ·750 | ·74 | 350 | ·93 | ·81 | 472 | 1·25 |
| 5·5 | ·825 | ·78 | 368 | ·97 | ·85 | 496 | 1·31 |
| 6·0 | ·900 | ·81 | 385 | 1·02 | ·89 | 518 | 1·37 |
| 6·5 | ·975 | ·85 | 401 | 1·06 | ·93 | 540 | 1·43 |
| 7·0 | 1·050 | ·88 | 416 | 1·11 | ·96 | 561 | 1·49 |
| 7·5 | 1·125 | ·91 | 432 | 1·14 | 1·00 | 581 | 1·54 |
| 8·0 | 1·200 | ·94 | 446 | 1·18 | 1·03 | 601 | 1·60 |
| 8·5 | 1·275 | ·97 | 460 | 1·22 | 1·06 | 620 | 1·64 |
| 9·0 | 1·350 | 1·00 | 474 | 1·26 | 1·09 | 638 | 1·69 |
| 9·5 | 1·425 | 1·03 | 487 | 1·29 | 1·12 | 656 | 1·74 |
| 10·0 | 1·500 | 1·06 | 500 | 1·33 | 1·15 | 673 | 1·78 |

| FALL OF DITCH. | | T—4 ft.; B—1 ft.; D—9 in. | | | T—4 ft. 4 in.; B—1 ft.; D—10 in. | | |
|---|---|---|---|---|---|---|---|
| Feet per Mile. | Inches per Chain. | Velocity. | Gallons per Minute. | Acre Inches per Hour. | Velocity. | Gallons per Minute. | Acre Inches per Hour. |
| ·5 | ·075 | ·25 | 174 | ·46 | ·27 | 221 | ·59 |
| 1·0 | ·150 | ·37 | 260 | ·69 | ·40 | 330 | ·88 |
| 1·5 | ·225 | ·46 | 325 | ·86 | ·50 | 413 | 1·09 |
| 2·0 | ·330 | ·54 | 380 | 1·00 | ·58 | 483 | 1·28 |
| 2·5 | ·375 | ·61 | 429 | 1·13 | ·65 | 544 | 1·44 |
| 3·0 | ·450 | ·67 | 472 | 1·25 | ·72 | 598 | 1·58 |
| 3·5 | ·525 | ·73 | 512 | 1·36 | ·78 | 649 | 1·71 |
| 4·0 | ·600 | ·78 | 549 | 1·45 | ·84 | 696 | 1·85 |
| 4·5 | ·675 | ·83 | 583 | 1·55 | ·89 | 740 | 1·96 |
| 5·0 | ·750 | ·88 | 616 | 1·63 | ·94 | 780 | 2·06 |
| 5·5 | ·825 | ·92 | 650 | 1·72 | ·99 | 821 | 2·18 |
| 6·0 | ·900 | ·96 | 677 | 1·78 | 1·03 | 858 | 2·27 |
| 6·5 | ·975 | 1·00 | 705 | 1·87 | 1·07 | 893 | 2·36 |
| 7·0 | 1·050 | 1·04 | 732 | 1·95 | 1·11 | 929 | 2·46 |
| 7·5 | 1·125 | 1·08 | 759 | 2·01 | 1·16 | 961 | 2·55 |
| 8·0 | 1·200 | 1·12 | 784 | 2·07 | 1·20 | 995 | 2·63 |
| 8·5 | 1·275 | 1·15 | 808 | 2·14 | 1·23 | 1,025 | 2·71 |
| 9·0 | 1·350 | 1·18 | 832 | 2·21 | 1·27 | 1,056 | 2·81 |
| 9·5 | 1·425 | 1·22 | 855 | 2·27 | 1·30 | 1,085 | 2·88 |
| 10·0 | 1·500 | 1·25 | 878 | 2·33 | 1·34 | 1,115 | 2·95 |

TABLE X—*continued.*

| Fall of Ditch. | | T—4ft. 8 in.; B—1 ft.; D—11 in. | | | T—5 ft.; B—1 ft.; D—12 in. | | |
|---|---|---|---|---|---|---|---|
| Feet per Mile. | Inches per Chain. | Velocity. | Gallons per Minute. | Acre Inches per Hour. | Velocity. | Gallons per Minute. | Acre Inches per Hour. |
| ·5 | ·075 | ·29 | 278 | ·74 | ·30 | 342 | ·90 |
| 1·0 | ·150 | ·43 | 414 | 1·09 | ·45 | 508 | 1·34 |
| 1·5 | ·225 | ·53 | 518 | 1·37 | ·56 | 634 | 1·68 |
| 2·0 | ·330 | ·62 | 606 | 1·61 | ·66 | 742 | 1·97 |
| 2·5 | ·375 | ·70 | 681 | 1·81 | ·74 | 835 | 2·22 |
| 3·0 | ·450 | ·77 | 750 | 1·99 | ·82 | 917 | 2·43 |
| 3·5 | ·525 | ·83 | 813 | 2·15 | ·89 | 995 | 2·64 |
| 4·0 | ·600 | ·89 | 871 | 2·31 | ·95 | 1,066 | 2·82 |
| 4·5 | ·675 | ·95 | 926 | 2·46 | 1·01 | 1,133 | 3·00 |
| 5·0 | ·750 | 1·00 | 978 | 2·60 | 1·06 | 1,197 | 3·17 |
| 5·5 | ·825 | 1·05 | 1,027 | 2·73 | 1·12 | 1,255 | 3·32 |
| 6·0 | ·900 | 1·10 | 1,075 | 2·85 | 1·17 | 1,316 | 3·48 |
| 6·5 | ·975 | 1·15 | 1,120 | 2·98 | 1·21 | 1,358 | 3·59 |
| 7·0 | 1·050 | 1·19 | 1,163 | 3·08 | 1·26 | 1,418 | 3·74 |
| 7·5 | 1·125 | 1·24 | 1,205 | 3·20 | 1·31 | 1,472 | 3·89 |
| 8·0 | 1·200 | 1·28 | 1,245 | 3·29 | 1·35 | 1,523 | 4·04 |
| 8·5 | 1·275 | 1·32 | 1,283 | 3·40 | 1·39 | 1,570 | 4·16 |
| 9·0 | 1·350 | 1·36 | 1,323 | 3·50 | 1·44 | 1,616 | 4·25 |
| 9·5 | 1·425 | 1·39 | 1,360 | 3·61 | 1·48 | 1,662 | 4·32 |
| 10·0 | 1·500 | 1·43 | 1,395 | 3·70 | 1·52 | 1,705 | 4·39 |

## TABLE XI.

TABLE SHOWING CHARACTERISTICS OF THREE PUMPS DELIVERING 800 GALLONS PER MINUTE THROUGH 70-FOOT TOTAL HEAD.

| Pump. | Speed R.P.M. | Efficiency, Per cent. | H.P. Required. |
|---|---|---|---|
| 4-inch .. .. .. .. .. .. | 1,075 | 41 | 35 |
| 5-inch .. .. .. .. .. .. | 785 | 60 | 23 |
| 6-inch .. .. .. .. .. .. | 690 | 62 | 24 |

PERFORMANCE OF 2-INCH, 3-INCH, 4-INCH, AND 5-INCH PUMPS UNDER DIFFERENT HEADS—CAPACITY IN GALLONS PER MINUTE.

2-INCH PUMP.—Total head in feet (efficiency 40 or over).

| Motor. | | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H.P. | R.P.M. | | | | | | | | | | | | | |
| 5 .. .. | 1,700 | .. | .. | .. | .. | .. | .. | 160 | 140 | 110 | 70 | .. | .. | .. |
| 3 .. .. | 1,700 | .. | .. | .. | .. | .. | 140 | 120 | 85 | .. | .. | .. | .. | .. |
| 2 .. .. | 1,700 | .. | 150 | 135 | 125 | 110 | 80 | 45 | .. | .. | .. | .. | .. | .. |
| 3 .. .. | 1,400 | 175 | 168 | 159 | 148 | 135 | 115 | 95 | 50 | .. | .. | .. | .. | .. |
| 2 .. .. | 1,400 | 160 | 145 | 130 | 110 | 90 | 70 | 45 | .. | .. | .. | .. | .. | .. |

3-INCH PUMP.—Total head in feet (efficiency 50 or over).

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 .. .. | 1,700 | .. | .. | .. | .. | .. | .. | .. | .. | 330 | 285 | 200 | .. | .. |
| 7½ .. | 1,700 | .. | .. | .. | .. | .. | .. | 370 | 300 | 245 | 125 | .. | .. | .. |
| 5 .. .. | 1,700 | .. | .. | .. | 335 | 315 | 280 | 255 | 175 | .. | .. | .. | .. | .. |
| 3 .. .. | 1,700 | .. | 300 | 280 | 260 | 225 | 175 | 75 | .. | .. | .. | .. | .. | .. |
| 2 .. .. | 1,700 | 260 | 230 | 190 | 125 | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| 7½ .. | 1,400 | .. | .. | .. | .. | 340 | 315 | 290 | 225 | .. | .. | .. | .. | .. |
| 5 .. .. | 1,400 | .. | .. | 340 | 310 | 280 | 250 | 215 | 100 | .. | .. | .. | .. | .. |
| 3 .. .. | 1,400 | 300 | 280 | 265 | 235 | 195 | 135 | .. | .. | .. | .. | .. | .. | .. |

4-INCH PUMP.—Total head in feet (efficiency 55 or over).

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 .. .. | 1,700 | .. | .. | .. | .. | .. | .. | .. | .. | 520 | 450 | 360 | .. | .. |
| 10 .. .. | 1,700 | .. | .. | .. | .. | .. | .. | 500 | 415 | 340 | 240 | .. | .. | .. |
| 7½ .. | 1,700 | .. | 500 | 475 | 450 | 425 | 390 | 355 | 260 | .. | .. | .. | .. | .. |
| 5 .. .. | 1,700 | 460 | 430 | 395 | 350 | 305 | 250 | 180 | .. | .. | .. | .. | .. | .. |
| 7½ .. | 1,400 | .. | .. | .. | .. | 520 | 480 | 450 | 370 | 260 | .. | .. | .. | .. |
| 5 .. .. | 1,400 | .. | 475 | 455 | 430 | 400 | 355 | 300 | .. | .. | .. | .. | .. | |
| 3 .. .. | 1,400 | 390 | 360 | 325 | 290 | 240 | 175 | .. | .. | .. | .. | .. | .. | .. |

5-INCH PUMP.—Total head in feet (efficiency 60 or over).

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 .. .. | 1,700 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 800 | 750 | 620 | 460 |
| 15 .. .. | 1,700 | .. | .. | .. | .. | .. | .. | .. | .. | 710 | 630 | 520 | 350 | .. |
| 15 .. .. | 1,700 | .. | .. | .. | .. | 770 | 740 | 700 | 610 | .. | .. | .. | .. | .. |
| 7½ .. | 1,700 | .. | .. | .. | 650 | 600 | 560 | 510 | 440 | 360 | .. | .. | .. | .. |
| 5 .. .. | 1,700 | 600 | 550 | 500 | 450 | 375 | 300 | 200 | .. | .. | .. | .. | .. | .. |
| 15 .. .. | 1,400 | .. | .. | .. | .. | .. | .. | 750 | 675 | 560 | 400 | .. | .. | |
| 10 .. .. | 1,400 | .. | .. | .. | .. | 700 | 650 | 610 | 500 | 350 | .. | .. | .. | .. |
| 7½ .. | 1,400 | .. | .. | .. | 600 | 560 | 500 | 450 | 250 | .. | .. | .. | .. | |
| 5 .. .. | 1,400 | 550 | 530 | 500 | 450 | 400 | 300 | .. | .. | .. | .. | .. | .. | |

## TABLE XII.

(FROM U.S.A. BULLETIN, No. 158.)

| Length of Base of Triangle. | Number of times Triangle must be applied in a mile. | Length of Leg at B to get fall of— | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 4 ft. per mile. | 5 ft. per mile. | 6 ft. per mile. | 7 ft. per mile. | 8 ft. per mile. | 9 ft. per mile. | 10 ft. per mile. |
| Feet. | | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. |
| 10 | 528 | $0\frac{1}{16}$ | $0\frac{1}{8}$ | $0\frac{1}{8}$ | $0\frac{3}{16}$ | $0\frac{3}{16}$ | $0\frac{3}{16}$ | $0\frac{1}{4}$ |
| 11 | 480 | $0\frac{1}{8}$ | $0\frac{1}{8}$ | $0\frac{1}{8}$ | $0\frac{3}{16}$ | $0\frac{3}{16}$ | $0\frac{1}{4}$ | $0\frac{1}{4}$ |
| 12 | 440 | $0\frac{1}{8}$ | $0\frac{1}{8}$ | $0\frac{3}{16}$ | $0\frac{3}{16}$ | $0\frac{3}{16}$ | $0\frac{1}{4}$ | $0\frac{1}{4}$ |
| 15 | 352 | $0\frac{1}{8}$ | $0\frac{3}{16}$ | $0\frac{3}{16}$ | $0\frac{1}{4}$ | $0\frac{1}{4}$ | $0\frac{5}{16}$ | $0\frac{5}{16}$ |
| 16 | 330 | $0\frac{1}{8}$ | $0\frac{3}{16}$ | $0\frac{3}{16}$ | $0\frac{1}{4}$ | $0\frac{5}{16}$ | $0\frac{5}{16}$ | $0\frac{3}{8}$ |
| $16\frac{1}{2}$ | 320 | $0\frac{1}{8}$ | $0\frac{3}{16}$ | $0\frac{1}{4}$ | $0\frac{1}{4}$ | $0\frac{5}{16}$ | $0\frac{5}{16}$ | $0\frac{3}{8}$ |

NOTE.—It is obviously not possible to get a greater accuracy with this implement than that which may be assumed from above Table. Where extreme accuracy is necessary spirit-levelling must be resorted to.

## TABLE XIII.

SHOWING FLOW OF WATER THROUGH 8-INCH BY 12-INCH SLUICE BOXES.

| Height of Opening. | 8 Inches Wide. Gallons per minute. | 12 Inches Wide. Gallons per minute. | Height of Opening. | 8 Inches Wide. Gallons per minute. | 12 Inches Wide. Gallons per minute. |
|---|---|---|---|---|---|
| 1 inch .. | 103 | 153 | 7 inch .. | 580 | 875 |
| 2 inch .. | 196 | 300 | 8 inch .. | 624 | 942 |
| 3 inch .. | 284 | 432 | 9 inch .. | 674 | 1,008 |
| 4 inch .. | 364 | 553 | 10 inch .. | 708 | 1,075 |
| 5 inch .. | 464 | 666 | 11 inch .. | 750 | 1,158 |
| 6 inch .. | 510 | 774 | | | |

Figures above approximate to result given by Q. 1250 L —
Depth of water above bottom of opening.
Depth of water above top of opening.

## APPENDIX I.

### Centrifugal Pump Data Sheet.

*Data Required for Estimates.*

The conditions under which pumping units operate vary considerably. In order to enable us to furnish final figures and correct recommendations by return mail, the purchaser should give the information requested below. In sending inquiries, please answer all the questions as fully as possible, for by so doing you will assist us in making proper recommendations. Fill in this sheet and mail with inquiry.

*Capacity, &c.*

1. Number of pumps required.....
2. Capacity of each.....U.S. gallons per minute.
3. Character of liquid—Fresh water, muddy, gritty, acidulous, solids in suspension ?.....
4. If solid matter is contained, state size and character of largest pieces.....
5. Temperature of liquid.....° Fahr. Specific gravity.....
6. Service continuous..... Service intermittent.....

*Head.*

7. Discharge head.....ft. (This is the vertical distance between the floor level of the pump and the point at which the water is discharged.)
8. Diameter of discharge pipe..... Length.....
9. Number of elbows in discharge pipe.....45 or 90 degrees..... Long or short radius.....
10. Suction lift.....ft. (This is the vertical distance from the floor level of the pump down to the surface of the water from which supply is taken.)
11. Suction head.....ft. (Sometimes the pump is placed so that water will flow into it. In such case the pressure at the suction opening of the pump should be stated and Question No. 10 omitted.)
12. Diameter of suction pipe.....length.....
13. Number of elbows in suction pipe.....45 or 90 degrees..... Long or short radius.....
14. Variation in discharge head, if any.....
15. Variation in suction lift, if any.....in suction head.....

*Motive Power.*

16. Belted—Give speed of motive power.....diameter of driving pully.....
17. Direct connected to motor—Direct current, voltage.....alternating current, voltage..... cycles..... phase.....
18. Direct connection to steam turbine—Steam pressure.....condensing..... Non-condensing.....
19. Direct connection to steam engine—Steam pressure.....condensing..... Non-condensing.....
20. Motive power furnished by purchaser.....by builder.....
21. Remarks .....

## APPENDIX II.

### RELATIVE COST OF PUMPING BY ELECTRICITY AND GASOLINE.

No general rules can be given for cost of pumping, owing to variation in local power rates. The following examples will serve as a general guide.

Comparative operating costs of gasoline and electrically-driven pumping plants in California, from tests made by Agriculture Department, corrected for current prices of gasoline :

*Average Results.*

Average results from actual tests are given in each case, and no attempt made to reconcile these figures, so that same can only be used as a general guide. The result for electric plants are for units owned and operated by large irrigation companies who keep accurate records of attendance and repairs, and in addition have heavy items of administrative expense, so that these charges are not strictly comparable with the corresponding items for small privately owned gasoline plants, which represent all but three of the gasoline plants tested.

| | Gasoline Plants. | Electric Plants. |
|---|---|---|
| Number of tests | 11 | 13 |
| Discharge—G.P.M. | 759 | 526 |
| Total lift—feet | 87·9 | 77·3 |
| Useful water horse-power | 10·24 | 9·93 |
| Indicated horse-power | 28·36 | 23·68 |
| Plant efficiency | 35 per cent. | 42 per cent. |
| Power consumed per hour (gallons gasoline, KWH, elec.) | 3·15 | 17·68 |
| Power consumed per useful water HPH | ·360 gal. | 1·95 KW |
| Number of hours plant runs per year | 1,349 | 2,096 |
| Power used per year (gallons gasoline, KWH, elec.) | 5,364 | 41,161 |
| Power cost (gallons gasoline, KWH, elec.) | $0·08 | $0·022 |
| Total cost of plant | $2,832 | $2,971 |
| Fixed charges per year (20 per cent. gasoline, 15 per cent. motor) | $566 | $446 |
| Cost of power per year | $429 | $913 |
| Cost of attendance and repair per year | $126 | $255 |
| Total cost per year | $1,121 | $1,614 |
| Fixed charges per useful water HPH | 0·179 | 0·041 |
| Power charges per useful water HPH | 0·029 | 0·042 |
| Attendance and repair per water HPH | 0·018 | 0·011 |
| Total | 0·226 | 0·097 |

## APPENDIX III.

### WEIGHT AND COMPARATIVE VALUES OF WOOD FUEL.

One cord of wood—4 feet by 4 feet by 8 feet = 128 cubic feet.

One cord of air-dried hickory, hard maple, or Australian hardwood weighs about 4,500 lb., and is equal to one ton of coal.

One cord of air-dried white oak weighs about 3,850 lb., and is equal to about 1,715 lb. of coal.

One cord air-dried beech, red oak, or black oak, weighs about 3,250 lb., and is equal to about 1,450 lb. of coal.

One cord of air-dried pine weighs about 2,000 lb., and is equal to about 920 lb. of coal.

From the above it is safe to assume that 2¼ lb. of dry wood is equal to one pound of average coal, and that the full value of the same weights of different woods is very nearly the same. That is, a pound of hardwood is worth as much and no more than a pound of pine, assuming both to be dry.

It is important that the wood be dry, as for every 10 per cent. of moisture present, the loss of heating value is about 12 per cent.

# APPENDIX IV.

## FLOW IN FLUMES.

### Velocity in Feet per Second and Quantity in Gallons per Minute for Various Sizes of Flumes with fairly smooth Surfaces — Unplaned Plank or Concrete Fluming.

Velocity in feet per second = $C r^{0.67} s^{0.54}$

S. Slope.
r. Hydraulic radius in feet.
C. Constant 160.

| Slope per 100 feet. | Cross Section in Feet. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 by ½. | 1½ by ¾. | 2 by 1. | 3 by 1½. | 4 by 2. | 5 by 2½. | 6 by 3. | 7 by 3½. | 8 by 4. | 9 by 4½. | 10 by 5. |
| ¾-inch—Velocity in feet per second .. | 1·18 | 1·54 | 1·87 | 2·46 | 2·98 | 3·46 | 3·91 | 4·33 | 4·74 | 5·13 | 5·50 |
| Gallons per minute .. .. .. | 220 | 650 | 1,400 | 4,140 | 8,920 | 16,200 | 26,300 | 39,700 | 56,700 | 77,700 | 103,000 |
| 1½-inch—Velocity in feet per second .. | 1·71 | 2·24 | 2·72 | 3·57 | 4·33 | 5·03 | 5·68 | 6·30 | 6·89 | 7·46 | .. |
| Gallons per minute .. .. .. | 320 | 940 | 2,030 | 6,010 | 13,000 | 23,500 | 38,200 | 57,700 | 82,400 | 113,000 | .. |
| 3-inch—Velocity in feet per second .. | 2·49 | 3·26 | 3·96 | 5·19 | 6·30 | 7·31 | 8·26 | 9·16 | 10·02 | .. | .. |
| Gallons per minute .. .. .. | 470 | 1,370 | 2,960 | 8,730 | 18,800 | 34,200 | 55,600 | 83,900 | 120,000 | .. | .. |
| 4½-inch—Velocity in feet per second .. | 3·10 | 4·06 | 4·93 | 6·46 | 7·84 | 9·10 | 10·29 | 11·40 | .. | .. | .. |
| Gallons per minute .. .. .. | 580 | 1,710 | 3,690 | 10,900 | 23,500 | 42,500 | 69,300 | 104,000 | .. | .. | .. |

## APPENDIX V.

## FLOW OF WATER IN CHANNELS.

TABLE OF VELOCITIES FOR VARYING SLOPES AND HYDRAULIC RADIUS—*r*.

V—for ordinary earth channels. V—for concrete lined channels or ordinary unplaned plank fluming.

*Velocities in Feet per Second.*

| Radius in Feet. | | Slope in Feet per Mile. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0·25. | 0·5. | 0·75. | 1·0 | 1·5. | 2·0. | 2·5. | 3·0. | 4·0. | 5·0. | 6·0. | 8·0. | 10·0 |
| 0·5 | Earth | ·261 | ·380 | ·473 | ·552 | ·688 | ·803 | ·906 | 1·00 | 1·17 | 1·32 | 1·45 | 1·70 | 1·92 |
| | Concrete | ·465 | ·676 | ·841 | ·982 | 1·22 | 1·43 | 1·61 | 1·78 | 2·08 | 2·34 | 2·59 | 3·02 | 3·41 |
| 1·0 | Earth | ·416 | ·605 | ·752 | ·879 | 1·09 | 1·28 | 1·44 | 1·59 | 1·86 | 2·10 | 2·31 | 2·70 | 3·05 |
| | Concrete | ·740 | 1·08 | 1·34 | 1·56 | 1·95 | 2·27 | 2·56 | 2·83 | 3·30 | 3·73 | 4·11 | 4·80 | 5·42 |
| 1·5 | Earth | ·546 | ·793 | ·987 | 1·15 | 1·44 | 1·68 | 1·89 | 2·09 | 2·44 | 2·75 | 3·04 | 3·54 | 4·00 |
| | Concrete | ·971 | 1·41 | 1·76 | 2·05 | 2·55 | 2·98 | 3·36 | 3·71 | 4·34 | 4·89 | 5·40 | 6·30 | 7·11 |
| 2·0 | Earth | ·662 | ·962 | 1·19 | 1·40 | 1·74 | 2·03 | 2·29 | 2·53 | 2·96 | 3·34 | 3·68 | 4·30 | 4·85 |
| | Concrete | 1·18 | 1·71 | 2·12 | 2·49 | 3·10 | 3·62 | 4·08 | 4·50 | 5·26 | 5·93 | 6·54 | 7·64 | 8·62 |
| 2·5 | Earth | ·768 | 1·12 | 1·39 | 1·62 | 2·02 | 2·36 | 2·66 | 2·94 | 3·43 | 3·87 | 4·27 | 4·99 | 5·63 |
| | Concrete | 1·37 | 1·99 | 2·47 | 2·89 | 3·59 | 4·20 | 4·74 | 5·23 | 6·11 | 6·89 | 7·60 | 8·88 | 10·00 |
| 3·0 | Earth | 8·68 | 1·26 | 1·57 | 1·83 | 2·28 | 2·67 | 3·01 | 3·32 | 3·88 | 4·38 | 4·83 | 5·64 | 6·36 |
| | Concrete | 1·54 | 2·24 | 2·79 | 3·26 | 4·06 | 4·75 | 5·35 | 5·90 | 6·90 | 7·78 | 8·59 | 10·03 | 11·31 |
| 3·5 | Earth | ·963 | 1·40 | 1·74 | 2·03 | 2·53 | 2·96 | 3·34 | 3·68 | 4·30 | 4·85 | 5·35 | 6·25 | 7·06 |
| | Concrete | 1·71 | 2·49 | 3·10 | 3·62 | 4·50 | 5·26 | 5·93 | 6·55 | 7·65 | 8·63 | 9·52 | 11·12 | 12·55 |
| 4·0 | Earth | 1·05 | 1·53 | 1·91 | 2·23 | 2·77 | 3·24 | 3·65 | 4·03 | 4·70 | 5·31 | 5·86 | 6·84 | 7·72 |
| | Concrete | 1·87 | 2·72 | 3·39 | 3·96 | 4·93 | 5·75 | 6·49 | 7·16 | 8·37 | 9·44 | 10·41 | 12·84 | 13·72 |
| 4·5 | Earth | 1·14 | 1·66 | 2·06 | 2·41 | 3·00 | 3·50 | 3·95 | 4·36 | 5·09 | 5·74 | 6·36 | 7·40 | 8·35 |
| | Concrete | 2·03 | 2·95 | 3·67 | 4·28 | 5·33 | 6·22 | 7·02 | 7·75 | 9·05 | 10·21 | 11·27 | 13·16 | 14·85 |
| 5·0 | Earth | 1·22 | 1·78 | 2·21 | 2·58 | 3·22 | 3·76 | 4·24 | 4·68 | 5·46 | 6·16 | 6·80 | 7·94 | 8·98 |
| | Concrete | 2·17 | 3·16 | 3·93 | 4·60 | 5·72 | 6·68 | 7·54 | 8·32 | 9·71 | 10·96 | 12·09 | 14·12 | 15·97 |

# BREEDS OF PIGS.

E. J. SHELTON, H.D.A., Instructor in Pig Raising.

## BERKSHIRE PIGS—THEIR SUPERIOR QUALITIES.

The British Berkshire Society, in whose herd books the leading British Berkshire breeders have for many years past registered their stud animals, has recently been engaged in a progressive movement aiming at popularising this famous old breed amongst the men engaged in pig raising the world over. Some of the special characteristics which they bring under the notice of breeders are as follows, and Berkshire breeders in Queensland would do well to note these several points and use them in advertising their stock:—

BERKSHIRES.

"Make more meat from meal than any other breed."

"They are hardy, docile, and exceptionally good mothers."

"They cross well with the best breeds, and improve the quality of the coarser ones."

"They thrive in climates as widely divergent as those of India and Canada."

"They obtain a premium from the leading bacon curers."

"They have won the Championship and Reserve Championship over all breeds in all carcase classes at Smithfield Show since their inauguration in 1904."

"They have won the Championships for the Best Pair of Pigs nineteen times (no other breed has won this more than three times)."

"They have won the Championship for the Best Single Pig nineteen times (no other breed has won this more than five times) at the thirty-seven Smithfield Shows since 1883."

"They have won the Whitley Challenge Cup for the Best Bacon Breed at the London Dairy Show. This record is unrivalled in the history of British live stock."

"The reason is: They yield more weight for age and a higher proportion of lean to fat, for a given weight, than any other breed."

Our illustration shows the superior quality of the Modern Berkshire Pig. Motto: "Breed Better Berkshires."

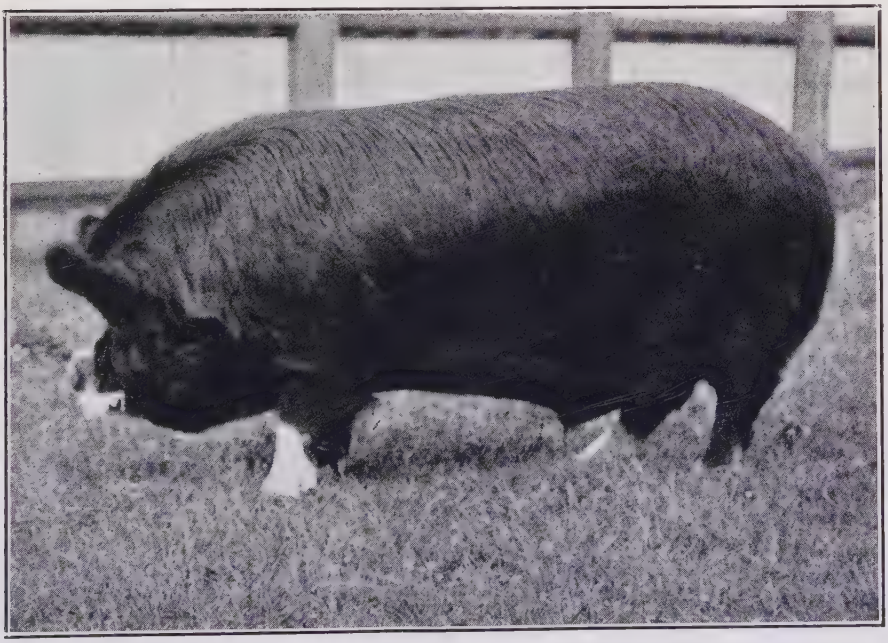

Plate 55.—"Meadow Chief."

First Prize, under 15 months; also Champion, Christchurch Show, 1922.
Bred by and the property of G. H. Barnett, Green Meadow, Leeston, Canterbury, N.Z.

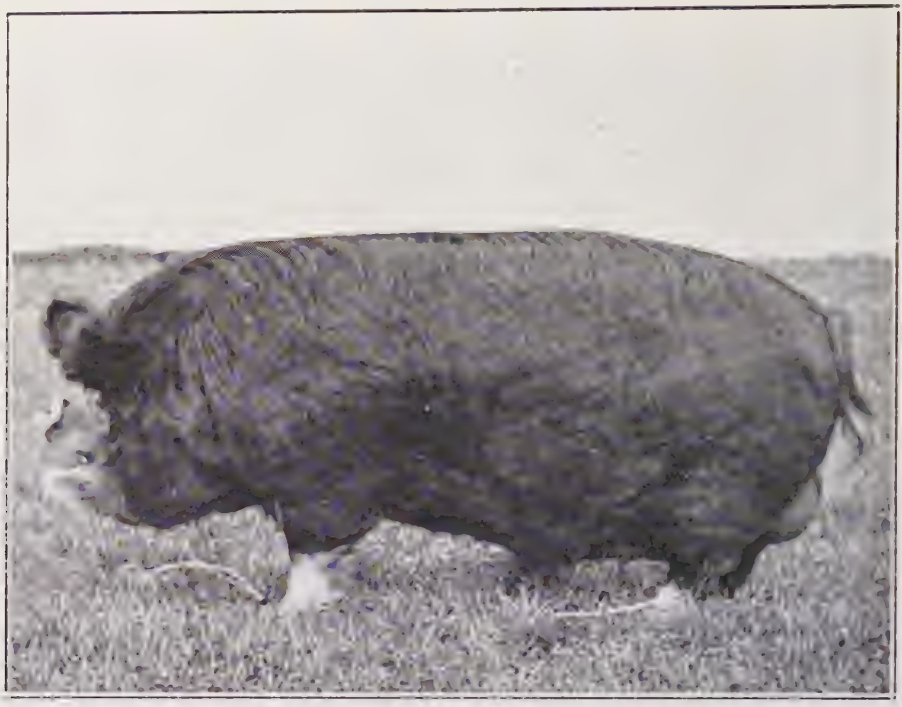

PLATE 56.—"CONARGO CHOICE."
An Australian and New Zealand Champion. The property of G. H. Barnett, "Green Meadow," Leeston, Canterbury, New Zealand.

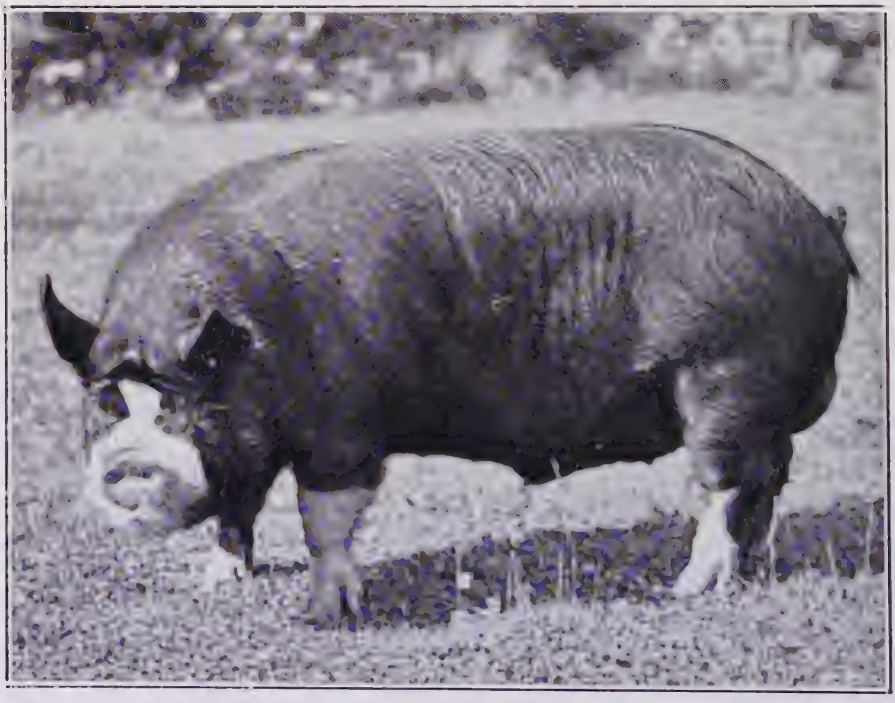

PLATE 57.—"MEADOW BRIGADIER"
A Yearling Prize-winner. The property of G. H. Barnett, "Green Meadow," Leeston, Canterbury, New Zealand.

Plate 58.—"Meadow Belle."
A Prize-winning Yearling Sow. The property of G. H. Barnett, "Green Meadow," Leeston, Canterbury, New Zealand.

Plate 59.—"Meadow Queenie."
A Prize-winning Sow. The property of G. H. Barnett, "Green Meadow," Leeston, Canterbury, New Zealand.

## THE BELL PIG—A PECULIAR BIRTHMARK.

The accompanying Plate illustrates a peculiar and characteristic birth-mark in some strains of the older type of Berkshire. The peculiar bell-shaped, fleshy growth under the lower jaw (the jowl) of this sow has been inherited from a line of blood, the origin of which does not appear to have been recorded.

Bell pigs were at one time common in some of the dairying districts in New South Wales, and the writer has received numerous inquiries from time to time as to their origin.

This photograph was secured through the courtesy of Mr. H. P. Jeffery, of "Greenwood," Moruya, New South Wales. On one occasion when the writer was visiting that district, the sow was then rearing a dozen hefty, vigorous suckers, every one of which had these peculiar bell-shaped growths well developed and distinct.

It would be interesting to have further information on this subject, and if any readers of the Journal have had any experience with Bell pigs the writer would be pleased to hear from them.—E. J. Shelton, H.D.A., Instructor in Pig Raising.

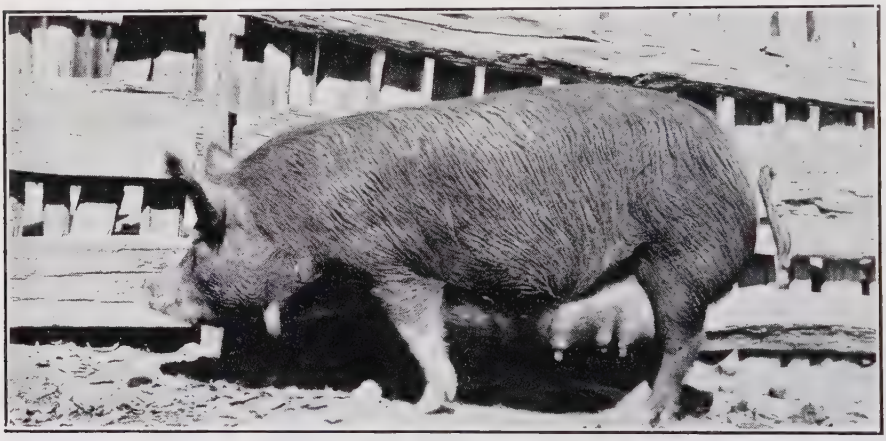

PLATE 60.—THE BELL PIG.

## CARCASSES OF PIGS DAMAGED IN TRANSIT.

E. J. SHELTON, H.D.A., Instructor in Pig Raising.

The accompanying illustrations, which have been secured through the courtesy of Messrs. J. C. Hutton Limited, bacon curers, of Roma street, Brisbane, and Zillmere, depict in a striking manner one of the most serious of the losses to the bacon-curer and to the pig industry in general, as a result of careless, even brutal, handling of pigs in transit to the saleyards, in trucking, and in delivery to the bacon factory.

The pigs were originally purchased by the company as first-class baconers, for which top rates had been paid. On slaughter, however, it was found that they were damaged to such an extent through being beaten with whips and sticks, being prodded, kicked, and otherwise mauled, that their real value was reduced more than 50 per cent. They had to be converted into small goods instead of being used for first-class bacon as was originally intended.

The bruised and scarred condition of various portions of other carcasses which had likewise suffered is depicted, the bruises in many instances not showing out until curing has proceeded some time.

Bacon-curers estimate that the pig industry suffers loss to the extent of thousands of pounds annually as a result of careless handling, and it is hoped these illustrations will tend to emphasise the necessity of careful handling, and the provision of suitable saleyards in which the pigs can be handled to more advantage at point of despatch. Some country saleyards the writer has inspected are in a shocking condition; they are indirectly responsible for a good deal of the trouble referred to above.

Plate 61.

These Sides have been Bruised and Damaged to such an extent that they would be almost unsaleable in a "Fresh Meat" Market; as it is, their value to the bacon curer has been depreciated more than 50 per cent.

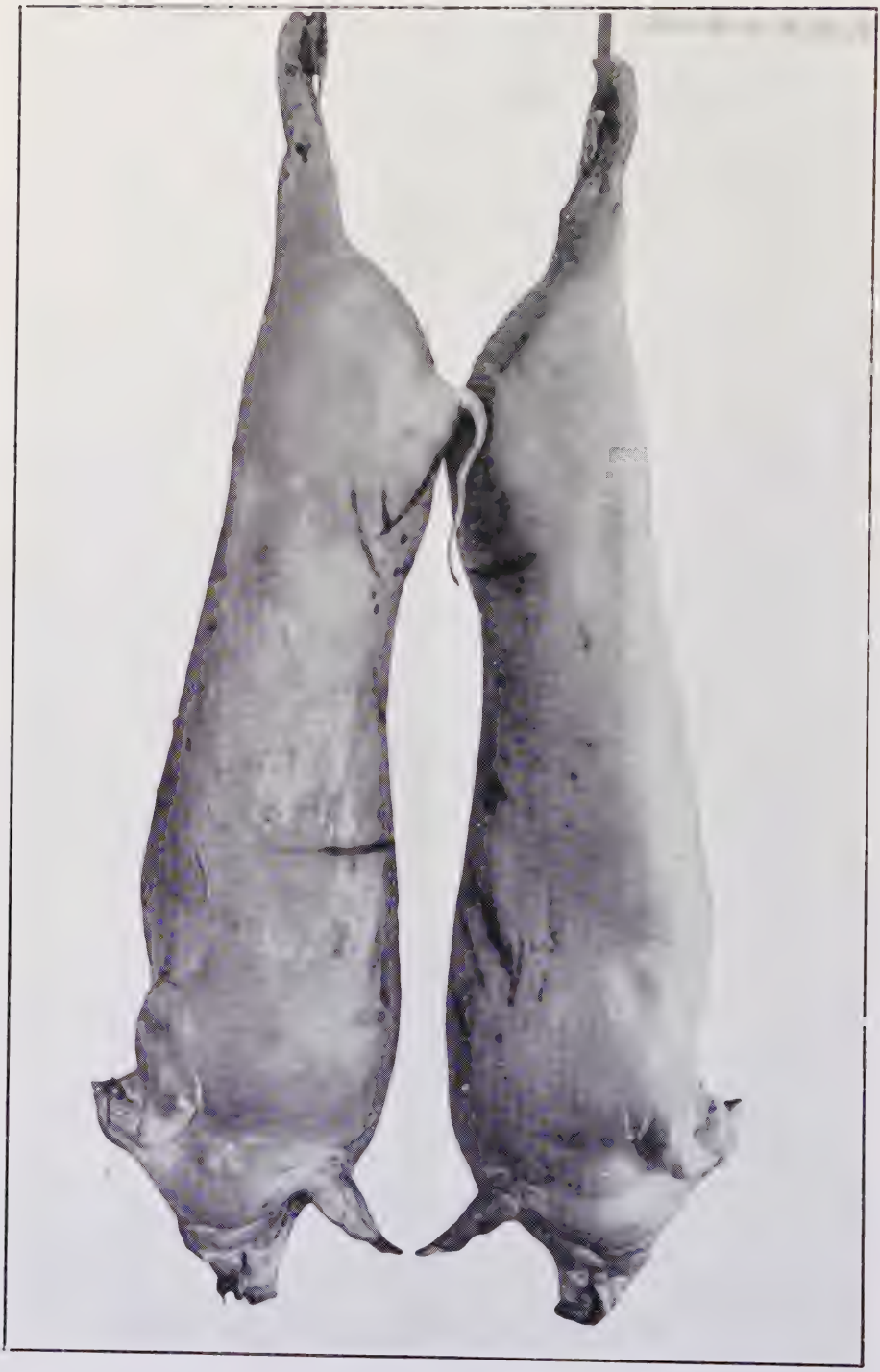

PLATE 62.

Note the bruised and scarred condition of the loin and back and disfigurement of the carcass generally.

Plate 63.

Note the many Bruises, Cuts, and Scores on these pieces of Bacon. The result of careless handling of the Live Pigs.

# FRUIT FLY INVESTIGATION.

*Report of the Entomologist stationed at Stanthorpe (Mr. Hubert Jarvis) for the months, December and January, 1923-24, on the Fruit Fly and other Injurious Insects, and made available by the Minister for Agriculture and Stock (Hon. W. N. Gillies).*

## FRUIT FLY.

### Records of Occurrence of Fruit Fly this Season.

*Stanthorpe District.*—The first fruit fly (as I have already stated, *vid.* Report October-November, 1923) was caught at the Summit on 30th October.

The first record obtained by me of fruit fly maggots in locally grown fruit was on 11th December, 1923.

The following are the dates of a sustained maggot infestation and the localities in which they occurred:—

| Date. | District. | Fruit. | Remarks. |
|---|---|---|---|
| December 12 .. | Fletcher Siding .. | Apples .. | Eggs and Maggots |
| December 12 .. | The Summit .. | Peaches .. | ,, ,, |
| December 12 .. | Applethorpe .. | Peaches .. | Maggots nearly full grown |
| December 12 .. | Eukey .. .. | Various Fruits | ,, ,, ,, |
| December 12 .. | Cottonvale .. | Peaches .. | ,, ,, ,, |
| December 13 .. | Stanthorpe .. | Apricots .. | ,, ,, ,, |
| December 20 .. | Ballandean .. | Peaches .. | ,, ,, ,, |
| January 7 .. .. | Amiens .. .. | Apples .. | ,, ,, ,, |
| January 14 .. .. | Spring Creek .. | Peaches .. | ,, ,, ,, |
| January 16 .. .. | Glen Aplin .. | Nectarines .. | ,, ,, ,, |

It will be seen from the above dates (that constitute a by no means complete record) that the fruit fly was fairly evenly, although lightly, distributed throughout a large portion of the district early in December (about one month later than characterised its distribution last season).

Although only one fruit fly was caught on 30th October, it is quite possible that others were present in the district at that time though not trapped.

### Outside the Stanthorpe District.

(1) *New South Wales.*—Almost simultaneously with its occurrence at the above places in the Stanthorpe district, the fruit fly (*C. tryoni*) was in the Marylands district, New South Wales (*i.e.*, 16th December) in various fruits, the maggots at that time being nearly full-grown. In fact, many had already left the fruit and entered the soil. From this fact we can conclude that the fruit fly had been operating at least twelve or fourteen days prior to 16th December in the Marylands district.

Fruit flies (*C. tryoni*) were, moreover, caught in traps at Marylands between 12th December and 16th December.

*Note.*—Last season the fruit fly was abundant in the Marylands and Amosfield districts some weeks before it made its appearance in the Stanthorpe orchards.

(2) *Warwick.*—Evidence of fruit fly (maggot stage) presence in loquats at Warwick was found by Instructor W. Leslie on 14th November, 1923.

(Last season they were found by myself and Mr. Perkins, B.Sc., in this fruit on 30th October.)

(3) *Toowoomba.*—Fruit fly maggots were found by Instructor W. Leslie in plums and in apricots on trees growing in Toowoomba on 22nd November, 1923.

(Last season fruit fly maggots were found by me in loquats growing at Toowoomba on 12th October.)

The foregoing records point to the fact that the fruit fly (maggot stage) this season, although about a month later, was present in certain localities outside the Granite Belt before it made its appearance in the Stanthorpe orchards; this was also the case last season.

**Origin of Fruit Fly in the Stanthorpe Area.**

Much has been written about the origin each spring of the fruit fly in this district. (1) Importation; (2) immigration; and (3) overwintering—have already been discussed in my previous reports (*vid.* Reports April-May 1922, June-July 1922, and August-September 1922), and each one of these three avenues, so to speak, may contribute its quota of fruit flies.

Briefly then to consider these:—

(1) *Importation.*—The danger of fruit fly importation into the Stanthorpe district was first realised by the writer on 10th October, 1922, on which date six cases of Valencia Late oranges, consigned to Stanthorpe, were found by Instructor J. Henderson and Inspector Williams to contain quantities of the maggots of the Queensland fruit fly (*C. tryoni*). Mr. Ranger, chairman of the District Fruitgrowers' Council, was at once communicated with on the discovery being made, and the maggot-infested fruit and cases were destroyed in our presence by fire.

Prior to this finding, however, many cases of oranges had been admitted to the district. (*Note.*—In no way can the inspectors be blamed for this, as it is extremely difficult, in examining consignments, to detect in any fruit the very young maggots or eggs of the fruit fly when present, and particularly so in the orange. In fact, to do this would necessitate the separate examination of each individual fruit with a magnifying glass. It is thus possible that many fruit flies may, last season, have resulted from such imported fruit.)

It was then decided to hold imported fruit at all stations throughout the Granite Belt until such fruit had been officially inspected.

This measure, however, failed to meet the situation owing to the number of stations at which the fruit was received, and to the difficulty of inspectors daily visiting these. The chief danger in this connection was the exit (which could not be obviated) of fruit fly maggots from the fruit during its detention at any of these stations while awaiting inspection.

When it was realised that the above measure had failed of its purpose, it was suggested by the writer that all fruit consigned to the Stanthorpe district should be placed in a cold chamber and subjected to a temperature of 33-35 degrees F. for not less than three weeks prior to its being sent to the Granite Belt.

The regulation under the Diseases in Plants Act embodying this suggestion came into force on 1st April, 1923, and it was hoped that this measure would prove entirely satisfactory in preventing any local importation of the living eggs and maggots of the fruit fly in citrus and other fruits subject to its attack.

This hope was not, however, realised, and failure in this respect was brought about by the following causes:—(1) Impracticability to maintain a constant temperature under Brisbane conditions of fruit cold storage; (2) difficulty of preventing fruit decay under cold-storage conditions, and temptation to make good this decay by drawing on supplies from fruit not cold-stored; and (3) difficulty of being sure of the fact of continuous cold-storage on the part of the officer issuing a certificate importing this.

Thus it was possible to find living fruit fly maggots in fruit that had been in cold storage for three weeks at a varying temperature.

This danger I first realised on 12th July, 1923, on which date living fruit fly maggots were found in imported oranges. These oranges, as was certified, had been cold-stored for three weeks at a temperature of 33-35 degrees F.

The Entomologist in Chief, Mr. H. Tryon, was at once communicated with on this discovery being made, and he immediately directed urgent attention to the matter in the proper quarter.

On 24th September, Instructor J. Henderson brought to this Office three fruit flies (*C. tryoni*) which he had bred from bananas. These bananas were imported some time in June and the flies hatched in August.

The breeding of these fruit flies from bananas was a matter of much importance, as this fruit was not included in the list of fruits to be cold stored before admittance into the Granite Belt (*vid.* Report August-September, 1923).

From that time onward to date, instances of living fruit fly maggots in various imported fruits continued to be discovered, particularly such fruits as mangoes, custard applies, papaw, and bananas. Thus it is only reasonable to conclude that many fruit flies originated in this manner and help to start the spring infestation.

(2) *Over Wintering; (a) As a pupa or adult.*—I have not yet obtained any evidence in favour of the fruit fly over-wintering (passing the winter) in this district as a pupa, and emerging in the spring by the "hatching out" of this pupa.

Experiments in 1922 and 1923 rather seem to indicate that this is not the habit of the fruit fly.

In both the abovementioned years a vigorous search was prosecuted during the winter and early spring months, in every possible situation, for fruit fly "puparia," and as a result many were found empty but none alive. Both moist and dry situations were thus examined—ones, too, under all kinds of late apples and quinces, and the soil to a depth of 12 inches put through a 1/10-inch mesh sieve. Again, the soil under various packing sheds and fruit dumps was also similarly examined. In no instance, notwithstanding this close examination, was a living pupa found at any of the above situations.

At the end of April and in May, 1923, maggot-infested fruit was placed under gauze covers and left in the open throughout the winter. In some cases these gauze covers were sheltered, and in others exposed to the frosts and weather generally.

During May many flies figuring in these experiments hatched, but none in the spring. (Examination of containers and insects of these experiments from time to time was made.) Similar infested fruit was held in the Insectary as a check in this experiment.

Records of fruit fly emergence kept by me during the months of April-May are given below:—

| Host Fruit | Date of Pupation. | Date of Emergence. |
|---|---|---|
| Quince | 5 April, 1923 | 13 April, 1923 |
| Quince | 5 April, 1923 | 16 April, 1923 |
| Quince | .. | 24 April, 1923 |
| Apple | 6 April, 1923 | 28 April, 1923 |
| Quince | .. | 30 April, 1923 |
| Quince | 2 May, 1923 | 7 May, 1923 |
| Quince | 3 May, 1923 | 10 May, 1923 |
| Quince | May, 1923 | 14 May, 1923 |
| Quince | 5 May, 1923 | 14 May, 1923 |
| Quince | May, 1923 | 17 May, 1923 |

One fly emerged on 25th June, 1923 (a cripple).

The above records were notes from the fruit kept in the Insectary and also from the fruit under the gauze covers abovementioned in the orchards.

*Note.*—It must be borne in mind, however, that any conclusions from experiments of the above nature that appear to be inevitable, might, under other seasonal conditions than those that have obtained during the last two winters, not hold good.

Experiments on the same lines will be continued this winter but on a larger scale.

*Over-wintering as an Adult Fly.*—Search has also been made for the adult fruit fly during the winter months, but without success.

Adult fruit flies have been kept alive for three months by me and can, it would appear, live much longer; and from general consideration I do not think it impossible for the fruit fly to survive the winter in some sheltered situation here, although I consider this very unlikely.

(3) *Immigration.*—The only other avenue by which the Stanthorpe district may obtain its fruit fly infestation is immigration, and, further, from districts outside the Granite Belt.

It is not impossible that, ordinarily, there may be immigration of the adult fruit flies over a considerable distance, especially when winds of a certain direction and the prevalence of certain flowers resorted to by the flies favour it.

The usual occurrence of the fruit fly in Toowoomba, Warwick, and Northern New South Wales prior to its appearance in this district would seem to favour this possibility.

The original scheme of research involved special experimental investigation to test this matter of immigration, but opportunity for carrying out these tests has hitherto been lacking. It is only recently that a lure really capable of attracting

the Queensland fruit fly (both sexes) has been discovered, and it is hoped by the aid of the lure, as an accessory to other procedures, to obtain some definite information in regard to this question of immigration.

The comparative freedom from fruit fly this season is a notable fact, not only in this district but also in other parts of Queensland and New South Wales.

In these other districts (both those of New South Wales and of Queensland) no special measures have been adopted either in reference to cleaning up orchards or the exclusion of maggot-infested fruit from elsewhere, so that the fly has had its usual chance to over-winter and increase. Its failure to do so is undoubtedly, therefore, largely due to seasonal conditions of a special nature.

The presence of the "Solanum fruit fly" in this district, early in the spring, is, I think, a fact in favour of the possibility of fruit fly immigration.

A certain lure will attract numbers of these flies (which are not of local origin) in almost any orchard throughout the district. Thus, if it is possible for this fruit fly (almost identical in structure with *C. tryoni*) to travel, it is only reasonable to concede this ability also to the latter species.

## CONTROL MEASURES.

### Collecting and Destroying Fly-Infested Fruit.

As has already been pointed out the most important control method, both here in Queensland and also in all countries where fruit flies have proved injurious to economic fruits, is the daily gathering and destruction of all "fly-stung" fruit, both that on the ground and also that on the tree. Where this has been consistently carried out in this district, there has been little or no loss from fruit fly attack. This fact has been repeatedly emphasised not only in my own reports, but also by every entomologist who has been engaged in fruit fly research work. Unless this "Orchard Hygiene" is adopted all other methods of attack or control will prove fruitless.

### Poison Bait Sprays.

It is yet too early to state if spraying fruit trees carrying fruit with a poisoned sweet is of any use in controlling the Queensland fruit fly.

Several orchards have this season been consistently sprayed with the molasses and arsenate of lead bait, and these orchards so sprayed have enjoyed a comparative immunity from fruit fly attack. This partial immunity has, however, also been shared by orchards in which no poison bait spray has been used.

Isolated orchardists in this district have suffered a considerable loss from fruit fly this season, but the majority have enjoyed comparative freedom from "fly." The difference in the degree of incidence of attack must be taken also into account in estimating the value of baits.

### Prohibiting Fruit Remaining in the District after 7th April.

A good deal of controversy has arisen over this projected fruit fly control method suggested by Mr. A. T. Perkins, B.Sc. (Research Entomologist—The University).

It is claimed by Mr. Perkins that all fruit fly maggots entering the soil before 11th April emerge before the winter and perish, and that those entering the soil after the 11th April hibernate (*vid.* Report, Perkins, 1st October-31st December).

Records kept by me of fruit fly pupation and emergence during the month of May, 1923, do not support this. Nevertheless, I deem his suggestion a most admirable one, and well worth trying, since, apart from fruit fly control, we have much to gain by it. Even if it does not reduce the fruit fly population it will prove, or should prove, a valuable control for codling moth, which has undoubtedly been very largely increased by the practice on the part of most growers of storing late apples and other fruits also in the packing sheds. Thus, the sending of all fruit out of the district by 7th April should considerably reduce the numbers of the first (the most important) seasonal hatching of this serious fruit pest. I state "fruit pest" because it not only attacks pomaceous fruits but also peaches and plums.

### Warwick Inspectors.

The appointment of Inspector Williams (to inspect all fruit consigned to the Stanthorpe district) at Warwick is undoubtedly a step in the right direction.

The Warwick Inspector, together with the Cold Storage Regulations, which we hope will still be maintained, should to a very large extent eliminate the danger of fruit fly introduction into the Stanthorpe district by otherwise uncontrolled traffic in fruit.

Should our annual occurrence of fruit fly in this district arise from over-wintering pupæ and from imported fruit alone (as I sincerely hope is the case, notwithstanding what has been stated now) a practical control of the fruit fly in the Stanthorpe district is within our reach, and should become assured.

## OTHER INJURIOUS INSECTS.

### Woolly Aphis (Natural Control Being Brought About).

The Woolly Aphis parasite, *Aphelinus mali* Hald., imported from New Zealand, 14th August, 1923, by courtesy of Dr. R. J. Tillyard, M.A., D.Sc., &c., will, I hope, become established in this district. One hundred and seven examples of this parasite were bred from the material sent me by Dr. Tillyard. These were liberated in three trees infested with Woolly Aphis; the last date on which parasites were liberated was on 28th September, 1923. From time to time the trees on which parasites had been liberated were examined, but nothing was seen of them until 20th January, 1924. On that date a large number of *Aphelinus* were discovered showing the characteristic hole made by the parasite in emerging.

Very many of these parasites must then have already hatched out and dispersed about the orchards in the Stanthorpe area, in which the majority of the first brood were liberated.

On carefully examining the apple trees in this orchard little or no Woolly Aphis was visible, so that my only fear is that the parasite may not, from lack of its host, continue to multiply.

Only one individual *Aphelinus* was recovered from twigs (bearing a few Aphids) taken from the tree on which they were first liberated and kept under conditions to admit of the obtainment of any specimens on issuing. Additional specimens will, I hope, hatch out in order to provide sufficient material to carry over the winter for use in distribution next spring.

Application has been made to Dr. Tillyard for an additional supply of the parasite to ensure its successful establishment in this district as a permanent useful endowment.

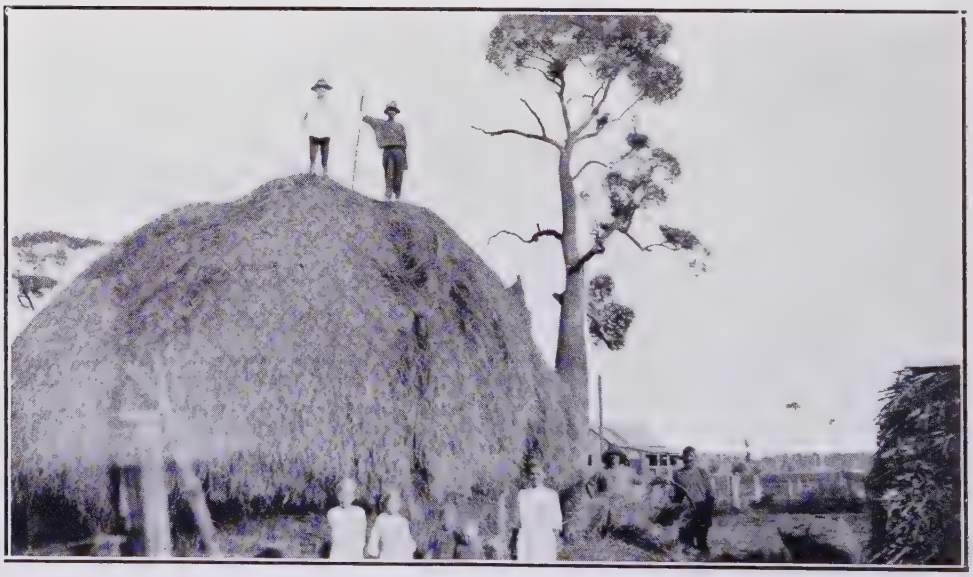

PLATE 64.—FODDER CONSERVATION.
Rhodes Grass and Sorghum Stacks on Mr. A. D. Drane's Farm.

# THE UPPER BURNETT.

## PROGRESS OF SETTLEMENT.

The Director of Agriculture, Mr. H. C. Quodling, in the course of a note on a recent visit to the Upper Burnett district, states that the country could not possibly look better. There is an abundance of grass everywhere, stock of all kinds look remarkably well, and at every centre along the railway line there is a marked activity and signs of renewed prosperity. At Gayndah, an average of an inch of rain per day was registered for the first eleven days in February, and this was supplemented immediately after by a general fall of between 5 and 6 inches. Following the opening of the various meatworks, fat cattle are in active demand; well-bred lines of young bullocks and steers for fattening purposes are selling well, but steers of dairying type and colour are of much lower values and hard to quit. Dairy cattle, close to profit, are in demand. Generally speaking, there is a greater activity in dairying as the result of the general rains.

### New Settlers.

An influx of new settlers to the Upper Burnett is giving a fillip to business generally. At present Eidsvold is being used as the rail head, and goods and chattels for the settlers are being carried through by ballast train. The opening of the railway to general traffic, in the immediate future, will give a stronger impetus to settlement. The new settlers in the Upper Burnett area are of fine type and are fairly numerous. Temporary shacks have been hurriedly erected, fencing is going on everywhere, and a great transformation is in progress. Some settlers have already taken dairy stock right on to their blocks, and are very keen to convert the superabundant growth of natural grasses into cash. Mile after mile of the flat lands on the upper portion of the Three Moon Creek are covered with grass 4 to 5 feet in height—rich succulent Blue grass for the most part; in fact, the whole country is carrying a magnificent stand of natural grasses. With cattle on the land and motor vans for carrying cream, new settlers would be able to secure immediate returns. A good market exists for good-quality dairy cows and heifers, as most of the recently acquired selections will be used for a time at least for dairying.

### Successful Demonstration Plots.

Commenting on the work carried out by the Department of Agriculture in establishing demonstration plots on areas in the Upper Burnett in advance of settlement, Mr. Quodling stated that some of the new settlers in the vicinity, whom he met, were very much impressed with the importance of the work. Many of those who settled on the scrub areas (upwards of 100,000 acres of this class of country were designed by the Lands Department for settlement) did so, after having ocular proof of the excellent growth made by the Rhodes grass on the 40-acre crop demonstration area at Monto. The crops on the Monal Creek Demonstration Farm, several miles from Monto, on the Monto-Many Peaks section of the line, looked remarkably well.

### Cotton Growing.

Cotton-growing experiments have been carried out on this site. New settlers in the vicinity are taking great interest in the operations. Some excellent agricultural land exists in this locality and on the upper waters of Three Moon Creek, near Cania Station. Given a run of favourable seasons, large quantities of dairy and agricultural produce should, in the near future, find its way to Gladstone from this region. Work on the railway line over the Dawes Range from Many Peaks is well advanced, and it is expected that this section of the line will be completed before the end of the year.

# BUREAU OF SUGAR EXPERIMENT STATIONS.

## ENTOMOLOGICAL HINTS TO CANE GROWERS.

By EDMUND JARVIS, Entomologist, Bureau of Sugar Experiment Stations.

During ploughing operations collect the grubs when plentiful. They will be mostly those of the greyback and the smaller reddish-brown cane-beetle *Lepidiota frenchi;* the former during this month being in the second and third stages, while the latter are fully grown third-stage grubs.

Be on the watch for grubs killed by the Green Muscardine Fungus (*Metarrhizium anisopliæ*) which is usually in evidence during March and April. When attacked by this vegetable parasite the body, instead of decomposing, retains its ordinary shape, and gradually hardening turns at first white and then an olive green colour. At this stage, being filled with fungus roots, these grubs become mummified, and can be broken into pieces as if formed of dry cheese.

The sphere of usefulness of this parasite could be greatly extended if growers would collect all such green, crusted-looking grubs, break them into powder, and thoroughly mix this with about 100 times the quantity of moist finely-sifted soil. This spore-laden earth should then be sprinkled very thinly in the furrows when ploughing up any grub-infested canefields.

Keep an eye open also for dead or dying grubs exhibiting black blotches on the sides or legs. These will probably be affected by bacterial diseases, and, unlike the preceding fungus-grubs, remain quite flaccid, and eventually decompose. Growers finding evidence of such disease are asked to communicate with the Entomologist at Meringa.

### Protect Your Beneficial Insects.

Do not pick up the soil-frequenting larvæ, &c., of insect friends of the cane-grower, which are parasitic or predaceous on grubs of our cane-beetles, and may be easily recognised by the following descriptions:—

(1) Plump, white, maggot-shaped inactive larvæ about an inch long, sometimes found attached to dead or dying cane-grubs. These turn into digger-wasp parasites.

(2) Dark-brown cocoons, about 1¼ inches long, with rounded ends; composed of silk hardened to the stiffness of thick paper. These contain digger-wasp parasites.

(3) White maggots, nearly 1½ inches in length, more slender than those of No. 1, and able to tunnel with ease through the soil by means of a pointed beak. These predaceous larvæ of Robber-flies pierce and suck the juices of cane-grubs.

(4) Larvæ, resembling flattened wire-worms, from 1 to 2 or more inches long, with yellowish-brown shining bodies and six small legs near the head-end. These slippery, very active creatures are predaceous on cane-grubs, &c., which they seize with sharp, sickle-shaped jaws, adapted for cutting through the skin of their unfortunate victims.

Continue to watch the growth of cane on low-lying flats where the beetle-borer (*Rhabdocnemis obscurus* has proved injurious during past seasons; and moth-borers have been observed during November and December.

"Dead-Hearts" occurring among stools where the sticks are from 3 to 5 feet high signify the presence of caterpillars of the Large Moth Borer (*Phragmatiphila truncata*). If numerous enough to attract attention such infestation should be brought under the notice of the Entomologist ('Phone 95, Gordonvale).

Similarly, should growers discover evidence of beetle-borers commencing to attack the basal portion of cane-sticks, it would be advisable for them to seek advice before the crop becomes seriously damaged.

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# SCIENCE NOTES.

By EDMUND JARVIS, Entomologist, Bureau of Sugar Experiment Stations.

## MELOLONTHID BEETLES AFFECTING SUGAR CANE.

The insects figured on the accompanying coloured plate, although being for the most part of minor economic interest, include at least two very destructive species (Nos. 1 and 7).

Fortunately, the grubs of *Lepidiota frenchi* Blackb., which are nearly as large and scarcely less injurious than those of our notorious greyback cane-beetle (*Lepidoderma albohirtum* Waterh.), do not damage cane-roots each season, only attaining full growth (third instar) every second year.

Although nearly twelve months of the life-cycle of *frenchi* are occupied by the first and second larval instars, the grubs do not during this period effect material injury to cane.

Both this species and *Lepidiota caudata* Blackb. (Fig. 7) are mainly destructive to roots of grasses, &c., appearing in some respects to take the place in North Queensland of some of the larger species of *Haplonycha*, two of which (*obesa* and *nigrescens*) are considered by French to be decidedly harmful to pasture land in Victoria. The grubs of *frenchi* occur freely throughout forest land in the Cairns district, subsisting largely on roots of the common "Blady Grass" (*Imperata arundinacea*); while those of *caudata*, which usually inhabit scrub lands, appear to be very partial to *Paspalum platycaule*, since out of forty-three grubs collected at random from among roots of this grass at Deeral in 1916, no less than 88 per cent. were found to be larvæ of this beetle.

Figures 8 and 9 illustrate the sexes of our so-called "Elephant Beetle," which, strictly speaking, is not a melolonthid, but a member of the family Dynastidæ.

The following brief biological notes regarding the eight species of coleoptera in question will doubtless be of interest to canegrowers.

### *Lepidiota frenchi* Blackb. (Fig. 1).

This cockchafer appears on the wing during November or December, usually being a few days behind the greyback.

Emergence takes place at twilight (about 6.45 p.m.), when suddenly and without warning of any kind myriads of these beetles arise simultaneously from every quarter and wildly dash to and fro, thousands being in view at the one time, which, in their erratic flight constantly knock against the cane-leaves, such sudden impact being plainly audible at a distance of several yards. In addition to this oft-repeated sound the air, so still before, vibrates with a continuous humming note, due to the accumulated buzzing of countless numbers of these insects.

Upon catching one, we shall notice a faint whitish bloom over-spreading the general body colour of reddish-brown, which, looked at with a pocket lens, is at once seen to be due to the presence of numberless tiny circular white scales resting in punctures.

The outer edges of the prothorax are dark-red, turned up slightly, and symmetrically scalloped, the hind margin of same being densely bordered with these curious scales. The ventral or lower surface of the body, including the legs, is thickly clothed with white scales, which on the thoracic plates vary from circular to pear-shaped, and near the coxæ are replaced by long silvery hairs.

The four life-cycle stages (egg to beetle) have been fully described by the present writer in Bulletin No. 5, Division of Entomology, of our Sugar Bureau, so need not be given here.

Although in evidence each season, *frenchi* is only excessively abundant every second year. Some idea of their numbers at such times may be gathered from the fact that, in 1915, four beetle collectors picked off in half an hour 23 lb. of these cockchafers whilst in the act of copulation from the wire fence of Gordonvale Recreation Reserve. About 475 specimens weigh 1 lb., so that the above quantity represented no less than 10,925 beetles.

The attitude assumed while mating is rather curious, as the female alone clings to the leaf-blade or other support (not the male, as inadvertently reported in Bulletin No. 5 of this Office (page 7)), the male hanging motionless head downwards in mid air supported only by the genital organs, and with the ventral surface of its body exposed to view.

### *Lepidiota consobrina* Gir. (Fig. 2).

Referring to the plate it will be noticed that this species closely resembles the preceding (*frenchi*) in general appearance and coloration. *Consobrina*, however, which emerges from the ground about three weeks earlier than the latter insect, is of local occurrence, much rarer on forest country, and if closely examined will be found to possess the following structural specific differences.

*The Larva.*—Setæ on venter of anal segment of both species arranged in the form of a pear-shaped figure, which in *consobrina* is elongated, having two parallel rows of short bristles. Width of head 7.20 mm. (in *frenchi* 5 mm.).

*The Beetle.*—Average length 1⅛ inches; (*frenchi* 1 inch). Antennal joints, Nos. 6 and 7 in male, stouter than in female. Teeth on outer edge of front tibiæ having the points more obtuse than in *frenchi*, and not equi-distant. Front tibial spur stouter and blunter than that of *frenchi*. The ventral transverse bands of scales on abdominal segments 1 to 4, narrower on centre and sub-ventral areas than in *frenchi*.

The grubs of this species often occur under cane-stools, and in localities near scrub land where the beetles are plentiful doubtless cause serious injury to the roots.

***Lepidiota grata* Blackb. (Fig. 3).**

The only previous record of this species was published in Bulletin No. 16 of our Division of Entomology, and refers to specimens of the beetle having been sent to us from Gin Gin. We have no actual evidence, however, of its being in any way injurious to sugar-cane.

***Lepidiota rothei* Blackb. (Fig. 4).**

This dark, shining, reddish-brown beetle emerges from forest land about the same time as *frenchi*, from which it differs in being much smaller (17.50 mm.), and in having the white scales on its elytra pear-shaped instead of circular.

Although grubs of *rothei* are often found under cane, their presence is probably due in many cases to the beetles having been attracted to such spots by a thick growth of weeds between the rows.

In its habits and mode of occurrence this species closely resembles *Lepidiota frenchi*, from which, however, it differs in having a life-cycle of only one year; and in being a cane-beetle of minor economic importance.

***Lepidiota froggatti* Macl. (Fig. 5).**

Fortunately, this fine melolonthid seldom attacks cane-roots, being in fact a rather rare species. It appears to frequent scrub lands, and is believed to have a two years' life-cycle, although one cannot make a definite statement on this matter until the life-history has been worked out.

***Lepidiota* No. 215. (Fig. 6).**

A glance at the accompanying plate will show the close similarity in form and colour between this species and *rothei* (Fig. 4).

Mr. A. M. Lee, indeed, the well known Coleopterist, to whom specimens were submitted in 1916, identified this beetle as being *Lepidiota rothei*, and up to the present it has remained unnamed. However, I have no doubt about its being specifically distinct from any of our other cane-beetles. It is slightly larger and darker than *rothei*, from which it differs very noticeably in having smaller and narrower scales, the centre of the clypeus more deeply notched, the central area of the abdomen less densely scaled, and in having darker legs. In addition to the foregoing distinctions this species has a two years' life-cycle; and, moreover, its larval and pupal stages present specific distinctions not found in those of *rothei*.

***Lepidiota caudata* Blackb. (Fig 7).**

This is a very interesting cane-beetle, which in the vicinity of scrub land at Babinda and elsewhere appears on the wing during September, and in some localities is believed to be a pest of premier importance. Its grubs are about as large as those of our greyback, and able to inflict serious injury to cane roots.

Freshly emerged beetles of *caudata* have an opalescent sheen, and the dorsal surface is sparingly and minutely punctulate, the scales although circular in form being much smaller than those of *frenchi*. *Caudata* has a two years' life-cycle, and is said to feed on the foliage of trees belonging to the family Euphorbiacæ.

***Xylotrupes australicus* Thoms. (Fig. 8 and 9).**

The large grubs of this well known dynastid, commonly termed "Elephant Beetle," feed mostly on vegetable humus, being often found in rubbish heaps of compost or decaying vegetable matter, and during 1914 were reported as occasionally occurring in canefields.

The beetles, which are attracted to light and sometimes fly into houses at nightime, feed on Poinciana and other trees. During 1910 I observed great numbers lying dead under several large Jacaranda trees that were growing in the courtyard of the Houses of Parliament, Brisbane.

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DESCRIPTION OF PLATE.

Fig. 1. *Lepidiota frenchi* Blackb.
Fig. 2. *Lepidiota consobrina* Girault.
Fig. 3. *Lepidiota grata* Blackb.
Fig. 4. *Lepidiota rothei* Blackb.
Fig. 5. *Lepidiota froggatti* Macl.
Fig. 6. *Lepidiota* No. 215.
Fig. 7. *Lepidiota caudata* Blackb.
Fig. 8. *Xylotrupes australicus* Thoms. (female).
Fig. 9. *Xylotrupes australicus* Thoms. (male).

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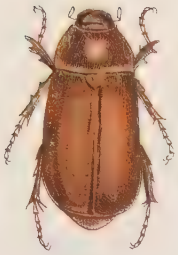

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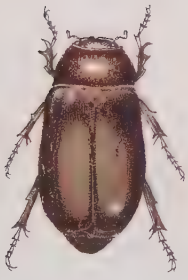

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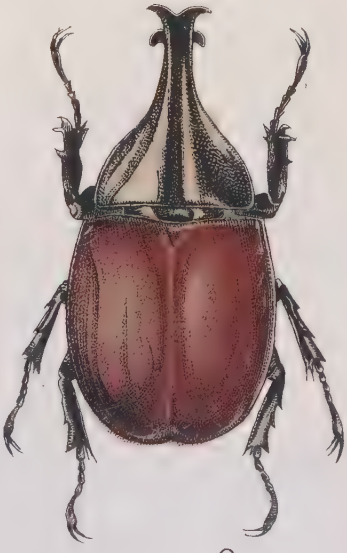

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# CANE PEST COMBAT AND CONTROL.

*The Director of the Bureau of Sugar Experiment Stations (Mr. H. T. Easterby) has received the following report, under date 28th February, 1924, from the Entomologist at Meringa, near Cairns (Mr. E. Jarvis).*

Now that the flighting of cane-beetles has ceased, one hears on all sides such questions as the following:—"Will grubs be plentiful this season?" "What damage are they likely to do?" etc., etc.

As previously mentioned in a recent report, greyback cane-beetles appeared this season, from December to January, in considerable numbers. During the fortnight preceding oviposition 150 points of rain fell, which being accompanied by an average temperature for those fourteen days of 79.50 degrees F., including a mean maximum temperature of 89 degrees F., permitted normal development of the eggs. It is important to note also that an additional 9.17 inches were registered during the period passed in the egg stage, prior to hatching of the first-stage grubs.

We may, therefore, infer from the above facts that climatic conditions having proved very favourable to the greyback cockchafer, its grubs are likely to show up presently in great numbers.

It will be remembered that last year this pest received a severe natural check; more than 50 per cent. of the beetles having perished in the ground owing to a long-continued spell of dry weather.

As pointed out in a previous report we may, I think, expect considerable damage to cane next April, although, in all probability, the general infestation will not come up to that experienced during normal seasons, in which the rainfall in the Cairns district for the period of four months, November to February, averages 49.32 inches.

At the present time, very few grubs of *albohirtum* have entered on the second instar; as out of 116 collected on 11th February only six were found to be in the second stage. By the end of this month, however, first-stage grubs of this species should be unprocurable.

Field investigations in this connection on the above date have revealed third-stage grubs of *frenchi* feeding amongst cane-roots on fairly dry soils at depths varying from 5 to 8 inches.

Out of thirty-six stools examined by Mr. G. Bates, grubs of *frenchi* were located under fourteen, and of *albohirtum* under eleven stools, while larvæ of both those cane-beetles were found together under two stools.

Examination of the soil beneath clumps of "star grass," and of sugar grass (*Sorghum halepense* Pers.) yielded an average of about eight first-stage *albohirtum* grubs feeding at depths of from 5 to 10 inches.

### Field Work.

Several experiment plots have been established this year in various localities, in order to accumulate further data in connection with the fumigant para-dichlor.; the efficiency of which as a grub destroyer was demonstrated last season at Meringa.

Present experiments are designed to determine the minimum amount of para-dichlor. required per acre to afford protection from this pest, and to kill its first and second stage grubs. It is hoped that this may be accomplished by injections of one-sixteenth of an ounce, placed 12 inches apart and 4½ inches deep.

Experimentation having been limited this season to the establishment of small plots consisting of from one-tenth to one-eighth of an acre, most of the work has been done with the "Jarvis Injector" invented for burying dry fumigants.

### Machine for Para-dichlor.

Growers will be interested to learn that early this season (15th October) the writer got into touch with Massey-Harris Company, Limited, with a view to getting them to build a machine for treating large areas with para-dichlor. The requirements of such an appliance were fully described, and as a result of various suggestions the firm endeavoured to meet the situation by making certain additions and alterations to one of their corn planters.

A machine was accordingly sent to us early in January, which when tested in the field succeeded in dropping and burying uniform quantities of para-dichlor. about 2 inches deep and 15 inches apart. This was effected by the use of four circular plates pierced with holes adapted for dropping doses of one-sixteenth, one-tenth, one-eighth, and one-fourth ounce.

As a result of this field test additional improvements in construction were effected locally, under the direction of Mr. McCawley, a representative of the firm of Massey-Harris. About a week later, when treating a plot of young cane with this machine, a few extra modifications were suggested by the operator, Mr. H. Knust, as being advisable in order that it might work more freely and uniformly on roughly cultivated areas. These improvements can be simply effected, and we are not likely to find need for additional alterations. At the present time, however, the machine in question can be used for treating well-worked cane land. Possibly final alterations may be completed in time for further trials this season.

This machine will not be costly, and being of simple construction is not likely to get out of order, as most of the mechanism is open to view, easily cleaned, and works freely.

Results already obtained in this direction, however, mark a decided step forward, since with such an appliance it will be possible for one man and a horse to fumigate from 3 to 4 acres a day, thereby reducing the cost of application to a minimum.

**Experiments with Calcium Cyanide.**

Last August, I received a letter from the American Cyanamid Company, of New York, drawing my attention to the merits of calcium cyanide, which is being used at present for destroying rabbits, orchard pests, fleas, wireworms, &c. A sample of this insecticide has now been obtained from Buzacott and Company, Limited, of Sydney, with which initial experiments have been commenced, with a view to testing its effect on grubs of our greyback cockchafer (*Lepidoderma albohirtum* Waterh.).

The sample forwarded is that marketed as Grade B, costing about 8d. per pound, and is in the form of a dark-grey powder, which during decomposition by the moisture of the air or soil generates hydrocyanic acid and calcium hydroxide. Although very deadly, this insecticide is not dangerous to handle if reasonable precautions be observed. The hydrocyanic acid gas is given off for a period of about twenty-four hours, thus allowing time for the fumes to penetrate some distance in moist soils open for such fumigation. It is worth noting also that the residue left behind in the ground after complete evaporation of the hydrocyanic acid contains no poison, as in the case of a material like arsenic, but is simply ordinary slaked lime.

Laboratory experiments started this month (February) with caged grubs of *albohirtum* are yielding very promising results, data obtained up to the present indicating that a dose consisting of only 8 grains of calcium cyanide is sufficient to kill first-stage grubs of *albohirtum* and third-stage grubs of *frenchi* in less than twelve hours, when sprinkled about 2 inches above the level at which they are feeding, and then covered over by a couple of inches of soil. The cages of earth used in this experiment were about 4 by 3½ inches in size, and left open at the top. We have yet to determine the distance that hydrocyanic acid gas will travel vertically and horizontally on each side of 8 to 15 grain injections, and what effect it may have on growing roots of cane.

I am of opinion that the poisonous nature of calcium cyanide will not prove a serious drawback to its use in canefields, since it would not, like Paris green or lead arsenate, &c., need to be dusted through the air, but simply buried underground.

The para-dichlor. machine being now completed for us by Massey-Harris, for instance, should be just the right thing for putting in calcium cyanide. Being enclosed in an air-tight container the fumes from this insecticide could not reach the operator, who would neither see nor smell it during its application to the soil.

The granular form of calcium cyanide would probably suit our purpose better than the Grade B dust, being more convenient to handle than the latter, and perhaps evaporating over a longer period.

The price of the former, put up in 200-lb. drums, is 17½ cents per pound.

## SUGAR: FIELD REPORTS.

The Acting Southern Field Assistant (Mr. A. P. Gibson) reports to the Director of Sugar Experiment Stations under date 14th February, 1924:—

### Yerra.

These sugar lands are of a hilly nature, they are not extensive, nor do they raise big tonnages. The soil varies from a light brown to red in colour, overlying not at a great depth a substratum of rock or clay. Growing cane on the frosted lowlands has been abandoned, and the highland area is gradually increasing.

The principal varieties planted on the new land are Rappoe and Striped Singapore, these generally do well and are favoured partly because they cover the rows quickly. D. 1135 is mostly planted on the older areas. The cane after harvesting is carted to the Government line and railed to the Mount Bauple mill.

### Childers.

The 1924 season commenced well with beneficial rains. Great activity prevails on the farms. The double-disc plough is favoured for hillside work. Hapsburg and Lynwood each have a modern set of steam ploughs at work, turning the soil up to 18 inches depth. Deep ploughing permits the plant roots to penetrate to a greater depth in the soil, thereby extending the feeding area, but the depth to which the ploughs can be used should, of course, be regulated by the natural depth of soil. It is said that these ploughs can do nearly an acre an hour under the best conditions. The majority of farmers have realised the importance of helping to restore the depleted organic matter by growing and turning in leguminous crops. This practice is indispensable. It is not correct agriculture to burn cane trash; this should be ploughed in.

The production of these volcanic red soils has been retarded by the general deficiency of moisture. Evidence of what water can do to advance the crop may be seen at present in moist places. The noisy but very useful Mynah birds is increasing rapidly in numbers, and no doubt is assisting to control insect pests, such as cattle ticks and army worms. Stormy rains have fallen, and a wonderful recovery is evident.

### Booyal and Dallarnil.

These districts came on the map as cane-producing areas twelve years ago, and in the year 1917 they raised their record crop. This was the production of two years. Owing to non-crushing of mills in 1916 the cane industry languished for a while on account of dryness, frosts, and costly production, dairying and cotton taking its place. Once again it is flourishing. The Isis Central mill lately has been calling for more cane, and offered the growers upward of £10 per acre to grow cane on approved highlands. This plan has worked wonders. Everybody is now talking cane. Already it is computed that 400 acres are under cane at Dallarnil and about 500 acres at Booyal. Further areas have been felled and made ready for planting.

Scrub felling costs 40s. to 45s. per acre. Cane holing by mattock, size of hole 14 by 6 by 9, and planting sets, 3s. per 100. Approximately, 3,000 sets are planted in an acre.

The principal varieties favoured are Rappoe, Striped Singapore, and D.1135. The two first-mentioned are giving satisfaction on new grounds, the latter on older soils. The largest growers at Dallarnil are Messrs. Munt, Brookfield, and Hamilton, whose cultivations aggregate about 190 acres. A little farm well tilled is often more profitable than a neglected big one. At Booyal, Messrs. Christensen and Coleman each have 13½ acres.

*Pests and Diseases.*—At Dallarnil green and brown grasshoppers are eating the cane leaves leaving only the midrib in places. Mosaic is generally found surrounding a patch of Shahjahanpur No. 10 variety. Farmers should lose no time in eradicating this variety. Root disease is noticed, more especially in older stubble of Rappoe and Striped Singapore.

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Report of the Northern Field Assistant (Mr. E. H. Osborn) under date 20th February, 1924:—

### South Johnstone.

A very big crop should again be harvested in 1924. Practically all the South Johnstone area looks well. The red volcanic on the higher grounds, and the alluvial on the lower areas show a uniformly healthy growth. On Nos. 6 and 7 Branches the cane looks at its best, while Kalbo and No. 1 Branch also show up well. At

the latter place Mr. B. Saleras, after cutting in the early part of the season, replanted in August, and it now carries a very fair crop. On the red soil in No. 7 (Mr. F. Schroeder) some very good March-planted Badila was noticed, carrying good cane. Between Japoon and the old construction camp, at Silkwood, the crops also look well. Old residents of this part of the district consider that the cane never looked better at this period of the year.

*Pests.*—So far this year no grubs have appeared. Borers have not done as much damage as in former years. Probably the numerous batches of Tachinid flies liberated in different parts of the district by the Entomological Branch have helped to lessen depredations.

*Diseases.*—The district at present is fairly free from diseases. Leaf scald was noticed in a few places in Badila ratoons, and rather more on the greyish alluvial soils than elsewhere. Growers cannot be too careful in planting any but the very best and healthiest of seed if they wish to keep their paddocks disease free.

**Mourilyan.**

The local mill has crushed 89,000 tons of cane for an average c.c.s. of 15, and a value per ton of 51s. The ration of burnt cane had amounted to only 11 per cent. This speaks well for the strict control that is exercised over cutting operations, and the high c.c.s. figures give an idea of how fresh the burnt cane must be when treated. The number of tons of cane taken to make a ton of sugar were 7.

*Cultivation.*—Cultivation in most parts of this area is sound, the cane generally being very clean, as were also the headlands. Large quantities of manures are used, and the outlook for 1924 is promising.

**Cowley Area.**

Between Mourilyan and this area and in the vicinity of Spring Water, some 200 odd acres of new land have recently been put under cane, a large proportion of which was low-lying country heavily covered with black palm.

This cane is remarkably green and healthy looking and is developing heavy crops. Possibly the two last seasons offered ideal growing conditions for this class of country. At Cowley some of the recently cut ratoons (especially some 5th Badila ratoons of Mr. J. McCutcheon) look good. This has been skeleton ploughed four times and has had the benefit of manure.

In Mr. McCutcheon's case his ratooning was carried out by a Titan tractor drawing a ratooning (automatic) plough. In the hot weather then being experienced the advantage of tractor power over horse-power was very plain.

Leaf scald was noticed in some Badila cane in this neighbourhood in cane yet to be cut, and more particularly in some first and older ratoons recently cut. In some places the young stools had completely died out.

**Liverpool Creek Areas.**

In the area known as Clump Point, through which Kaygaro, Little and Big Maria Creeks run, there is some particularly good land. In the Silkwood, and also in the area on the south side of Liverpool Creek, there are large blocks of land that could be successfully put under cane, and would be the means of permanently settling a large population.

**Babinda.**

The mill had just finished a successful although very long season, having crushed 163,821 tons of cane with an average c.c.s. of 13.80, and had manufactured 21,880 tons of sugar. These figures are Australian records for tonnage of cane crushed and for quantity of sugar manufactured in one season.

Among the crops particularly noticed was a block of second Badila ratoons of Messrs. Sycamore Brothers, on Babinda Creek. A large proportion of this is fairly heavy low-lying greyish soil. As a plant crop it cut a total of 207 tons. It was then well cultivated and a deep headland drain dug to carry off any surplus waters, with the result that as first ratoon crop it yielded some 410 tons. The recently cut cane is now ratooning well. In the vicinity of Harvey's Creek (red soil) some first ratoons looked very healthy.

*Leaf Scald.*—In my last notes on the Babinda area it was observed that disease was showing up in quite a number of scattered parts of the area, particularly in H.Q. 426 (Clarke's Seedling) and Green Goru (24B). Now that the cane has been cut the resultant ratoons show it up also, and rather more markedly; some stools gradually withering up and some dying right out. Possibly dry weather conditions may account for this to a certain degree, but scald certainly seems to be increasing in the Babinda area.

*Pests.*—So far the effects of grubs have not given any cause for worry.

The Acting Southern Field Assistant (Mr. A. P. Gibson) reports (6th March, 1924):—

**Mackay.**

These soils are low alluvial deposits, containing decomposed granite sand, and drained principally by the very shallow Pioneer River. During heavy floods there is a probability of bank erosion. At Farleigh and Habana the country is different, being hills and valleys mostly of a volcanic nature. Owing to these lands being adjacent to the sea and only a foot above it, it is necessary to have a perfect surface drainage system; this is by no means complete on many of the holdings.

Seasonal conditions were extremely adverse, practically three waterless months had been experienced. In January only 135 points of rain were recorded at Mackay, and all surrounding observing stations reported falls far below the average; in consequence the crop was then in a very backward condition. February rains averaged at least 15 inches at the time of my visit. Moist soil conditions, in conjunction with summer heat, have stimulated the crop to such an extent that it again possesses a glorious colour and is responding vigorously, but there is much leeway to make up. The crop out as far as the Palms looks better than that surrounding Walkerston. Patches of plant cane in isolated parts are well advanced.

*Cultivation.*—Weeds were growing apace, and where possible are being checked by the use of a light plough, the soil subsequently being levelled by a scarifier. When this is done the season's work will be completed in many paddocks. The use of the plough should be avoided as much as possible; it severs many roots upon which the crop depends, and is obviously responsible for a temporary cessation of growth.

Farmers are breaking up land that was not possible to work before the rain fell. Tractors of various makes are coming more into use on the larger holdings.

*Planting.*—It is a common practice to plant two or four drills of cane in lands; by so doing surplus water is hastened away. The varieties grown are many, and are as follows:—N.G. 15 (Badila) preferred on new scrub ground, H.Q. 426 (Clark's Seedling), Q. 813, Q. 819, Cheribon, M. 1900, Malagache (M. 189) on poorer soils, Black Innes (M. 87), D. 1135, and Uba cane. About 1 ton lime and from 4 to 6 cwt. meatworks have been applied per acre, but little increase in tonnage was noted owing to protracted dryness.

*Pests.*—Grasshoppers and caterpillars have been eating the cane leaves. Grubs and water fowl known as Red Bill, or Coot, have been responsible for much damage. This bird generally frequents swamps, and it pecks into the stem to such a degree that it tumbles or makes unsightly holes into the heart at the leaf-sheath of young cane; a paddock of young cane at Inneston was completely destroyed by this bird. *Pentodon Australis* is here, but doing little damage; beetles were observed on the pavement in the city; they evidently were attracted by a powerful picture show light. Workers were still shaking the mealy-back cane-beetles off the trees and collecting them.

*Progress.*—Sarina is the home of one of the most efficient mills of the district. Plane Creek was established in the year 1896, having then 39 suppliers, to-day there are 267. Last year it crushed 45,925 tons from 4,834 acres. Its record year was 1917, when 70,000 tons were crushed, and should the present season continue favourable 60,000 may be treated. The surrounding cane areas are scattered, necessitating some 50 miles of tramways; such areas generally require more supervision and increase transportation charges. M. 1900 is the favoured cane here. The crop on the whole looked surprisingly well and was further advanced than that of Mackay. Several growers have built their own tramlines, which generally enable them to remove their crops at all times. In one instance a motor-truck tractor is used for hauling purposes. Plane Creek expects big things in the near future from Carmilla and Koumala, new districts recently opened on the Rockhampton side of Sarina. At Carmilla, there are forty-three suppliers and 4½ miles of loco. track over which the cane is railed to the Government way; Koumala, twenty-three suppliers and 2 miles of line.

Homebush cane is now railed to Rosella. The method of loading from small to big wagons is quick and interesting. A powerful self-propelling steam truck crane operates on a 4-ft. 8½-in. line, situated between the Government line and the loaded small trucks. As this moves along it raises the cane off the small trucks either in slings or by lifting the truck bodily and spilling its contents into the large wagon. Several mills are extending their tramlines to newer areas.

The Southern Field Assistant (Mr. J. C. Murray) reports (19th March, 1924:—

**Woongarra.**

This area has brightened up remarkably since the beginning of February. The soil is in a very moist condition and humid weather prevails. Some farmers are making the mistake of trying to operate in these wet soils. It is better to lose a little time than do this.

Cane varieties that look well are Q. 813, D. 1135, H.Q. 285 (erroneously called Nerang), Uba, and M. 1900 Seedling. Nutgrass and "white eye" are probably the worst weeds the farmers have to contend with. Apparently very little damage has been caused by insects. Isolated patches of cane are showing leaf stripe and discolouration, but no secondary symptoms of cane disease were observed.

**Mary Road Area.**

Settlement is extending considerably along the railway between Bundaberg and the Elliott River crossing. The soil is a good-quality forest loam, and works up to a fine tilth. Good well water is plentiful. Farther out from Bundaberg on the Elliott River a number of farms are admirably situated for irrigation.

No loss, or very little, is being caused by insect parasites on the Maryborough road area. The farms have a clean, well-tended appearance, free from noxious weeds.

Cane varieties doing well include Black Innis, M. 1900 Seedling, Q. 813, N.G. 16, and D. 1135. Of these the farmers will probably find that on this soil Black Innis, Q. 813, and D. 1135 will give them the best returns. Growers are probably aware of the fact that cane holing should be followed as soon as possible by the plough. This soil is fairly productive when ploughed, but much of this productiveness is lost if the cane is planted with the mattock.

**Avondale.**

The cane in this locality is making a very fine showing, both here and across the river at Moorlands. Nutgrass causes some trouble in the young plant cane, but by keeping this down in the early stages of the crops' growth the subsequent loss is slight. Canes doing well at Avondale and Moorlands are Uba, Q. 813, D. 1135, B. 208, H.Q. 285, and M. 1900 Seedling.

The texture of a heavy soil may be ruined by ploughing it when it is wet; the soil is packed into great clods which may take years to dissolve. Of the varieties growing at Avondale and Moorlands, it is probable that Q. 813 and H.Q. 285 look the best. B. 208 is making a good showing.

**Springfield.**

The farmers here have had very heavy rains lately; in some instances large quantities of soil have been swept down to the lower portions of the farms. The outlook is very encouraging and the harvest, provided the winter is not early, should be a reasonably good one. Farmers here are not greatly troubled by noxious weed growth or parasites, their greatest drawback being lack of rail transport. As this area is rapidly developing, both from a tourist and farming point of view, it should almost pay the authorities to extend the standard gauge from Pemberton on to the Elliot Heads. Cane varieties looking well include M. 1900 Seedling, D. 1135, and Q. 813.

The by-products of meatworks should give results in these soils. Here, as elsewhere, the farmers are advised to let their heavier soils alone while wet.

**Oakwood.**

Similarly with other places, the cane at Oakwood has benefited greatly by the rain. The weeds are also growing, keeping the farmers busy. Varieties that are most noticeable are E.K. 1, M. 1900 Seedling, Black Innis, Q. 112, B. 208, H.Q. 285, Q. 1098, E.K. 28, and E.K. 2. This area presents a very healthy appearance just now. Disease is absent, and there are no indications of borers or rats. Bonedust is being used with satisfactory results.

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The Northern Field Assistant (Mr. E. H. Osborn) reports (20th March, 1924):—

**Cairns.**

Given favourable conditions from now on, large crops of cane should again be harvested by each of the local mills. Some D. 1135 first ratoons of Mr. Jno. Cannon, and some first ratoons Badila of Mr. J. Skene, at Highleigh, looked well.

At Freshwater, the cane seemed rather backward, more especially the easily-cut ratoons, but at Messrs. McManis and Painter's a 12-acre block of plant Badila looked good. These growers have just added to their already first-class plant a concrete dam, to prevent erosion caused by the Barron River during flood time.

*Cane Varieties.*—Several plots of the newer varieties of cane were inspected at Aloomba and Hambledon, mostly E.K. 28, H. 109, Q. 813, 7R. 428, H.Q. 458, and Q. 695. In all of these plots E.K. 28 has made good growth, both as plant and ratoons, as also has Q. 813, but at Mr. J. Smith's Hambledon Farm, Q. 695 has done the best. It struck well and shows very good growth of even-sized sticks carrying a healthy green top. The cane from which the plants were obtained did not arrow.

*Diseases.*—With the exception of one paddock, leaf scald did not appear as prevalent as expected. Where seen it was most apparent in N.G. 24B, N.G. 24, and H.Q. 426. Top-rot was, however, noticed, more especially in the Freshwater area, generally affecting single shoots.

H. 109 was noticed to be suffering from mosaic in several places, and it is not advisable to replant same. In the demonstration plot at the Mulgrave Central Mill evidence of leaf scald, and also mosaic, has shown up to a far greater degree than when last visited.

As mentioned previously, this plot is an example of the destruction that disease can cause, and is well worth visiting by every grower in the Cairns district.

**Herbert River Areas (Macnade).**

Splendid rains have fallen, freshening up the growing crops marvellously. Quite a large area of new land is included in the mill area this year. To cope with the crop a locomotive bridge has been built adjoining the one that has served the mill so long. The tramway system has also been added to considerably by extending to Gairloch, *viâ* Lily Pond, with a branch running into the new areas at Forest Home.

**Victoria.**

Very wet weather interfered with the time available in this part of the area, but practically the same conditions prevailed as at Macnade, except that the Ingham district had been favoured with more rain than Halifax.

*Diseases.*—The chief disease on the Herbert is undoubtedly "gumming," although leaf scald, leaf stripe, and mosaic are also in evidence. The situation in regard to the former is so very serious that in a circular dated 15th November last, the company state that it intends to ask the Local Cane Price Board to place Clark's Seedling (H.Q. 426) upon the list of disapproved varieties for both their mills. As this cane is grown in between a 30 per cent. and 40 per cent. proportion, it will easily be seen how serious the situation must be when such drastic steps are being considered. In the circular, it mentions that the valuable cane B. 208 was barred on the Herbert a few years ago on account of disease, and adds that even now small patches of it in the district still harbour the disease and hinder its eradication, and that it is desired to prevent the same position arising with Clark's Seedling and the gumming disease. In my previous report upon the area, leaf scald was spoken of as being seen in H.Q. 426, N.G. 15, and Korpi. The company are now exercising as close a supervision as possible over cane that is to be used for seed, any blocks that show traces of the disease spoken of being barred.

Leaf stripe was also noticed slightly in a block of first ratoons, D. 1135, that had cut about 45 tons per acre on very poor forest soil. Where this particular cane was grown the wallabies were very destructive to other varieties of cane growing alongside, but did not touch the D. 1135, much to the owner's surprise.

In the writer's opinion quite a large area of the poorer classes of land that will now probably be barred from growing H.Q. 426 would grow good crops of Q. 813, of which a fair quantity of seed should be available in the Macknade area later on.

**Lower Burdekin.**

Since my last visit to this district, conditions have improved wonderfully, thanks to the recent glorious rainfall, and a fair crushing seems assured. It is wonderful to note how very soon this area recovers, and gives one an idea of how fertile the Burdekin Delta would be under even ordinary weather conditions. Several blocks of healthy looking first ratoons were noticed—come H.Q. 426 of Mr. H. Wellington's, and H.Q. 426, N.G. 24 B, and N.G. 15 of the Kalamia Estate.

The former had been manured with about 5 cwt. per acre of mixed manure, whilst the Kalamia cane had two separate dressings, each of 1 cwt. per acre of nitrate of soda.

*Varieties* (newer).—Several small blocks of Q. 813 were noticed growing, one of the best of which was at Mr. Geo. Mackersie's at Clare. He also has some good Q. 903. Both of these canes compare very favourably with Green Goru, which he considers his best cane upon similar land. Mr. D. Ahern's (Airedale) was also seen, some uncommonly good E.K. 28 (Plant), most of which will be used for seed.

*Diseases.*—Leaf stripe was noticed in several blocks of B. 208 ratoons. In one badly affected paddock some stray Goru (N.G. 24) was also showing the disease. Most of the plant B. 208, however, looked right. Top rot was more in evidence this year than for the past few seasons, mostly in individual shoots. Climatic conditions are no doubt partly responsible for this.

## RAINFALL IN THE AGRICULTURAL DISTRICTS.

TABLE SHOWING THE AVERAGE RAINFALL FOR THE MONTH OF FEBRUARY, IN THE AGRICULTURAL DISTRICTS, TOGETHER WITH TOTAL RAINFALLS DURING FEBRUARY, 1924 AND 1923, FOR COMPARISON.

| Divisions and Stations. | Average Rainfall. | | Total Rainfall. | | Divisions and Stations. | Average Rainfall. | | Total Rainfall. | |
|---|---|---|---|---|---|---|---|---|---|
| | Feb. | No. of Years' Records. | Feb., 1924. | Feb., 1923. | | Feb. | No. of Years' Records. | Feb., 1924. | Feb., 1923. |
| *North Coast.* | In. | | In. | In. | *South Coast*—continued: | In. | | In. | In. |
| Atherton ... ... | 9·46 | 23 | 4·60 | 3·94 | | | | | |
| Cairns ... ... | 15·11 | 42 | 10·43 | 11·22 | Nambour ... ... | 8·71 | 28 | 8·29 | 5·91 |
| Cardwell ... ... | 16·86 | 52 | 11·27 | 5·32 | Nanango ... ... | 4·17 | 42 | 6 58 | 1 93 |
| Cooktown ... ... | 13·23 | 48 | 7·07 | 8·82 | Rockhampton ... | 7·33 | 37 | 8·31 | 0·42 |
| Herberton ... ... | 7·42 | 37 | 5·20 | 3·74 | Woodford ... ... | 8·60 | 37 | 7·16 | 2 88 |
| Ingham ... ... | 15·56 | 32 | 11·73 | 4·32 | | | | | |
| Innisfail ... ... | 21·87 | 43 | 15·79 | 14·51 | | | | | |
| Mossman ... ... | 15·61 | 15 | 8·50 | 8·78 | *Darling Downs.* | | | | |
| Townsville ... ... | 11·43 | 53 | 9·54 | 0·27 | | | | | |
| | | | | | Dalby ... ... | 2 81 | 54 | 3·37 | 0·32 |
| *Central Coast.* | | | | | Emu Vale ... ... | 2·15 | 28 | 5·99 | 0 00 |
| | | | | | Jimbour ... ... | 2·73 | 36 | 4·51 | 0·03 |
| Ayr ... ... ... | 8·60 | 37 | 15·69 | 0·12 | Miles ... ... | 2·57 | 39 | 8·89 | 0·07 |
| Bowen ... ... | 8·49 | 53 | 15·80 | 0·93 | Stanthorpe ... | 3·21 | 51 | 4·68 | 0·20 |
| Charters Towers .. | 4·30 | 42 | 13·54 | 0·43 | Toowoomba ... | 4·24 | 52 | 7·08 | 0 07 |
| Mackay ... ... | 11·35 | 53 | 21·09 | 1·92 | Warwick ... ... | 3·06 | 59 | 5·08 | 1·10 |
| Proserpine ... ... | 10·63 | 21 | 26·12 | 2·64 | | | | | |
| St. Lawrence ... | 7·90 | 53 | 9·94 | 2·29 | | | | | |
| | | | | | *Maranoa.* | | | | |
| *South Coast.* | | | | | | | | | |
| | | | | | Roma ... ... | 3·01 | 50 | 8·58 | 1·54 |
| Biggenden ... ... | 3·44 | 25 | 14.81 | 0·41 | | | | | |
| Bundaberg ... ... | 5·99 | 41 | 9·85 | 0·48 | | | | | |
| Brisbane ... ... | 6·31 | 73 | 9·26 | 0·69 | *State Farms, &c.* | | | | |
| Childers ... ... | 5·68 | 29 | 16·43 | 0·61 | Bungeworgorai ... | 2·34 | 10 | 7·09 | 1·21 |
| Crohamhurst ... | 13·85 | 30 | 7·69 | 3·47 | Gatton College ... | 2·74 | 25 | 12 06 | 0·00 |
| Esk ... ... ... | 5·25 | 37 | 7·00 | 0·15 | Gindie ... ... | 2·82 | 25 | 8·26 | 0·00 |
| Gayndah ... ... | 3·97 | 53 | 18·05 | 0·12 | Hermitage ... | 2·18 | 18 | 5·67 | 0·00 |
| Gympie ... ... | 6·51 | 54 | 11·10 | 1·48 | Kairi ... ... | 8·38 | 10 | 6·79 | 3·70 |
| Glasshouse Mts. ... | 8·28 | 16 | 7·71 | 4·32 | Sugar Experiment | | | | |
| Kilkivan ... ... | 4·87 | 45 | 7·83 | 1·65 | Station, Mackay | 9·95 | 27 | 21·18 | 2·09 |
| Maryborough ... | 6·44 | 53 | 10·04 | 5·18 | Warren ... ... | 3·89 | 10 | 5·95 | 0·15 |

NOTE.—The averages have been compiled from official data during the periods indicated; but the totals for February, 1924, and for the same period of 1923, having been compiled from telegraphic reports, are subject to revision.

GEORGE G. BOND,
State Meteorologist.

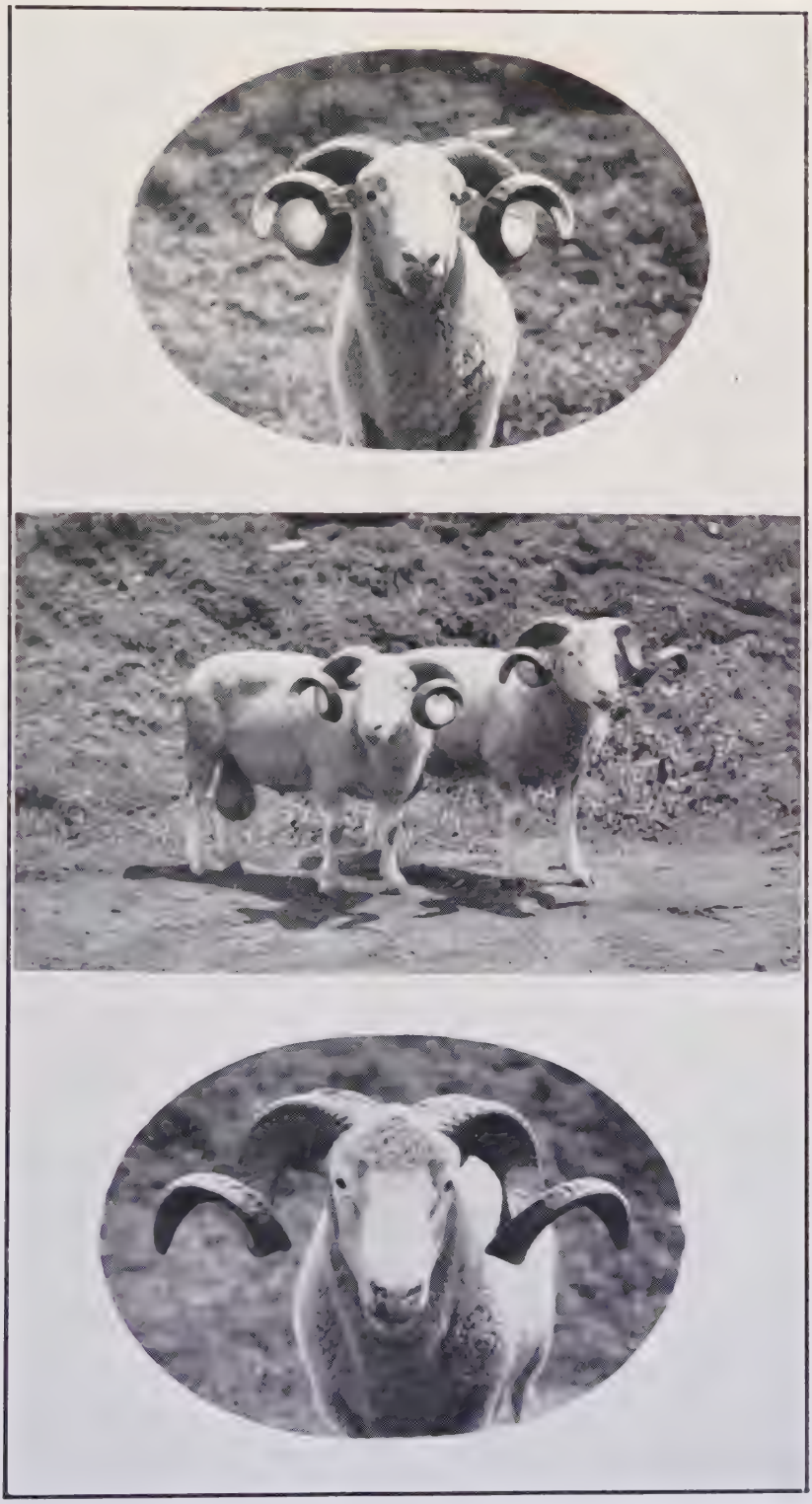

Plate 65.—Dorset Horned Sheep.

From Mr. H. McMartin's Flock, Pullen Vale, Indooroopilly, purchased by the Queensland Agricultural College Authorities for Breeding Purposes.

# General Notes.

### Quail Close Season.

The close season for Quails (all species) will continue until the 30th April, 1924.

### Cane Prices Boards.

Representatives upon and Chairmen of the Local Sugar Cane Prices Boards have now been appointed.

### Blackberry a Pest.

A Proclamation has been issued declaring the English Blackberry (*Rubus Fruticosus*) to be a pest within the Stanthorpe Fruit District.

### Embargo Raised.

An Order in Council dated 24th November, 1923, prohibiting the introduction of infected or suspected stock, or any carcass of infected or suspected stock, from the State of Western Australia, has now been rescinded.

### Bowen Fruit Export Society.

A notice has been issued under section 24 of "*The Primary Producers' Co-operative Associations Act of* 1923," declaring the Bowen Fruit Export Society, Limited, as a company which carries on operations of a co-operative nature in relation to primary produce under the abovementioned Act.

### Staff Changes and Appointments.

Messrs. W. Long, T. Southerden, L. Southerden, D. Pope, T. Smith, R. Prest, A. M. Richardson, P. Pfrunder, J. Munro, A. Brett, R. Nelson, A. L. Teitzel, S. McCosker, D. Walker, and H. S Pratt have been appointed Inspectors under and for the purposes of "*The Diseases in Plants Act of* 1916," as from the 31st March, 1924, to the 3rd May, 1924

Police Constable H. H. Taylor, of Yaamba, has been appointed an Inspector under and for the purposes of "*The Slaughtering Act of* 1898," as from the 10th March, 1924.

Mr. R. W. Mungomery has been admitted to the professional division of the Public Service and appointed Assistant Entomologist, Sugar Experiment Stations, Department of Agriculture and Stock, with headquarters at Meringa.

Mr. C. G. Munro has been reappointed Manager, State Farm, Home Hill, as from the 24th March, 1924.

Police Constable A. F. Kahler, Mungindi, has been appointed an Inspector under and for the purposes of "*The Slaughtering Act of* 1898," as from the 10th March, 1924.

Mr. Jas. Theodore Tod, of Goomburra, has been appointed to represent the Council of Agriculture on the Cheese Board as from the 21st March, 1924, to the 30th June, 1924.

The following have been appointed members of the Arrowroot Board from the 10th March, 1924, to the 9th March, 1925:—Alexander Clark, Pimpama; Charles Daniel Gordon, Redland Bay; Alexander McGregor Henderson, Redland Bay; Johannes Lahrs, Pimpama; and Robert Stewart, Ormeau.

Police Constables J. Lane and W. Newman have been appointed Inspectors of Slaughter-houses as from the 10th March, 1924.

The Officer in Charge of Police, Eton, has been appointed an Acting Inspector of Stock as from the 10th March, 1924.

The resignation of Mr. W. Rowlands as Fruit Packing Instructor, Fruit Branch, Department of Agriculture and Stock, has been accepted as from the 29th February, 1924, such position being abolished from that date. Mr. Rowlands has now been appointed Fruit Packing and Marketing Instructor, Department of Agriculture and Stock, for a period of three years as from the 1st March, 1924.

### Sugar Crop Prospects.

The Director of Sugar Experiment Stations (Mr. H. T. Easterby) recently returned from a visit to the Mackay and Bundaberg districts, and reports that the whole country along the railway line to Mackay has a splendid appearance, and grass and water are in evidence everywhere. The plentiful rains at Mackay, extending over six or seven weeks, have produced a marvellous transformation in the cane crops. A good crop is now assured, while an excellent one is possible if conditions remain favourable. The present estimate for this district is about 45,000 tons of sugar. Conditions at Bundaberg are extremely promising for a good yield, and cane has made fine progress during the past few weeks. Cane in the Woongarra sub-district, which was well behind the rest of the district, has now recovered and a fine crop is anticipated. Reports from the Childers and Nambour districts also indicate very favourable prospects for this year's crushing.

### Banana Grades.

Schedule 3 (relating to the grade standard of Cavandish bananas) of the "Fruit and Vegetable Grading and Packing Regulations of 1922" under "*The Fruit Cases Acts*, 1912-1922" has been deleted, and a Schedule substituted therefor, providing that—

"Choice" shall mean sound fruit, free from blemish and properly packed, having a minimum length of eight inches and a minimum circumference of five inches.

"Firsts" shall mean sound fruit, properly packed, having a minimum length of over seven inches to eight inches and a minimum circumference of four inches.

"Seconds" shall mean sound fruit, properly packed, having a minimum length of five and a-half inches to seven inches and a minimum circumference of four inches.

All measurements for length are to be taken on the outside of the curve from the junction of the fruit at the stem-end to the top of the fruit.

### Cotton Crop Prospects.

About 62,000 acres are under cotton in Queensland, compared with 30,000 acres last year. The crop this season, it is estimated, will be worth about £1,000,000.

The Acting Premier and Minister for Agriculture (Hon. W. N. Gillies), in the course of a recent Press announcement, stated that an attempt had been made this year by the Department of Agriculture and Stock to get out a reliable forecast indicating the acreage which had been cultivated under cotton, and which will be picked during the present season. A special card was issued to 9,281 growers in the course of the month of January. On these cards growers were asked to complete two statements—one showing the acreage which each grower expects to harvest, and the second one whether the prospects are for a good, fair, or poor crop. Replies have been received from 6,499 growers, and disclosed a planted acreage of 50,063 acres. Approximately 30 per cent of the growers to whom cards were sent have not yet replied. It would seem safe, however, to make an allowance for an additional quarter increase in area, which would bring the estimated area under crop to about 62,000 acres, since it must be remembered that many people had planted last year's seed.

"As to the future prospects of the crop," said Mr. Gillies, "it is as yet too early to comment. The early sown crop is generally good, but in many parts the crop is late owing to the delayed arrival of the spring rains and the dry subsoil at the time. As a result planting could not be done at the right time. These late crops have, in many cases, also suffered from the depredations of the maize grub and other insect pests, and so a great deal will depend on the weather during the rest of the season. The early arrival of frost will depreciate the crop, whereas if the cool weather holds off the late pickings will be materially increased."

### Opossums and Native Bears Protected.

The Acting Premier and Minister for Agriculture (Hon. W. N. Gillies) has announced the Cabinet's decision to the effect that there will be no open season this year for either opossums or native bears. Before submitting the matter to the Cabinet he had caused inquiries to be made throughout the whole of the State. In all 243 separate reports were received from stock inspectors, dairy inspectors, Crown land rangers, foresters, and officers in charge of police from all over Queensland. Of these reports a great number indicated that it would be very unwise to open the season this year, as opossums had suffered a very severe onslaught in the 1922-23 open season. To such an extent had their number been reduced that they were in danger of extinction in very many districts where they were formerly quite numerous. In 1922, over a million opossum skins were marketed in this State, and in 1923 the number was 1,200,000. In addition to these there must have been hundreds of thousands of young ones killed, whose skins were of no commercial value. In a few isolated localities opossums are still fairly numerous, but it would be quite impracticable to open the season in these particular sections and not for the rest of the State.

Reports in favour of the further protection of the native bears were even more unanimous. Taking the value of the skins at, say, 5s., the economic worth of opossums and native bears to the State is apparent. This value would be easily jeopardised were the season to be opened regularly every year; more especially as when once an opening is announced it is extremely difficult to keep trappers within the limits of the open period.

Another reason influencing the Cabinet in its decision was the fact that by keeping the season closed this year, the prices for skins in the future are likely to be considerably improved, as there are at present enormous numbers of opossum skins awaiting sale on the American and European markets. When these have been absorbed future values will be naturally enhanced.

### Co-operative Associations Act—Additional Regulations.

Additional regulations under "*The Primary Producers' Co-operative Associations Act of* 1923" have been issued which provide for, in accordance with the Act, the registration of Associations or Federations (fee, 10s.).

Forms of application will, in due course, be sent by the Registrar of Primary Producers' Co-operative Associations to the various Associations who have already applied for registration under the Act, and to others who in the future apply for registration; also for the registration of Secretaries, Treasurers, and Directors of Associations; the registration of amendments of Rules of Associations from time to time; the licensing of Auditors; the cancellation of registration of Associations or licenses of Auditors when deemed necessary for the exemption, withdrawal, or dissolution of Associations; exempting Associations or Companies from the operations of the Act by the Governor in Council on the recommendation of the Council of Agriculture; and the Scale of Fees.

### Cotton Grades and Rates.

The guaranteed rates for all grades for the 1924 season are tabulated as follows:—

| Grade. | 1¼ in. staple and over. | Less than 1¼ in. |
|---|---|---|
| A | 5½d. per lb. | 5d. per lb. |
| B | 5½d. per lb. | 5d. per lb. |
| C | 5½d. per lb. | 5d. per lb. |
| D | 5½d. per lb. | 5d. per lb. |
| E | 5d. per lb. | 4½d. per lb. |
| F | 4½d. per lb. | 4d. per lb. |
| G | 4d. per lb. | 3½d. per lb. |
| IMMATURE GRADES. | | |
| 1X | 5½d. per lb. | 5d. per lb. |
| 2X | 5d. per lb. | 4½d. per lb. |
| 3X | 4d. per lb. | 3½d. per lb. |

# Farm and Garden Notes for May.

Field.—May is usually a busy month with the farmer—more particularly the wheatgrower, with whom the final preparation of his land prior to sowing is the one important operation. Late maturing varieties should be in the ground by the middle of the month at the latest.

Cleveland, intended primarily for feeding off, should be sown not later than the end of April.

The necessity of pickling all wheat intended for sowing purposes is again emphasised; and for general purposes, combined with economy in cost of material, the bluestone and lime solution holds its own. To those who desire an easier but somewhat more costly method of treatment, carbonate of copper at the rate of 1 oz. to the bushel and used in a dry form is suggested.

Potatoes, which is many districts are still somewhat backward, should have by this time received their final cultivation and hilling-up.

The sowing of prairie grass on scrub areas may be continued, but should be finished this month. This is an excellent winter grass, and does well in many parts of Southern Queensland.

Root crops, sowings of which were made during April, should now receive special attention in the matter of thinning out and keeping the soil surface well tilled to prevent undue evaporation of moisture.

Every effort should be made to secure sufficient supplies of fodder for stock during the winter, conserved either in the form of silage or hay.

Cotton crops are now fast approaching the final stages of harvesting. Growers are advised that all cotton in the Central District should be consigned to the Australian Cotton-growing Association, Rockhampton; whilst those in the Southern areas should consign their cotton to the Association at Whinstanes, Brisbane. All bags should be legibly branded with the owners' initials. In this matter the consignor is usually most careless, causing much delay and trouble in identifying parcels, which are frequently received minus the address labels.

Kitchen Garden.—Onions which have been planted in seed beds may now be transplanted. The ground should long since have been thoroughly cleaned, pulverised, and should be rolled previous to transplanting. Onions may still be sown in the open on clean and well-prepared ground. In favourable weather plant out cabbages, lettuce, leeks, beetroot, endive, &c. Sowings may also be made of all these as well as of peas, broad beans, khol-rabi, radishes, spinach, turnips, parsnips, and carrots, and, where sufficiently large enough, thinned out. Dig and prepare beds for asparagus, using plenty of well-rotted farmyard manure.

Flower Garden.—Planting and transplanting may be carried out simultaneously during this month in showery weather; the plants will thus be fully established before the early frosts set in. Camellias and gardenias may be safely transplanted, also such soft-wooded plants as verbenas, petunias, pentstemons, heliotrope, &c. Cut back and prune all trees and shrubs ready for digging. Dahlia roots should be taken up and placed in a shady situation out of doors. Plant bulbs, such as anemones, ranunculus, snowflakes, freesias, ixias, watsonias, iris, narcissus, daffodils, &c. Tulips will not suit the Queensland climate, but hyacinths may be tried, although success is doubtful. All shades and screens may now be removed to enable the plants to get the full benefit of the air. Fork in the mulching, and keep the walks free from weeds. Clip hedges and edgings.

# Orchard Notes for May.

## THE COAST DISTRICTS.

In these notes for the past two months the attention of citrus-growers has been called to the extreme importance of their taking every possible care in gathering, handling, packing, and marketing, as the heavy losses that frequently occur in Southern shipments can only be prevented by so treating the fruit that it is not bruised or otherwise injured. It has been pointed out that no citrus fruit in which the skin is perfect and free from injury of any kind can become specked or blue-mouldy, as the fungus causing the trouble cannot obtain an entry into any fruit in which the skin is intact. Growers are, therefore, again warned of the risk they run by sending blemished fruit South, and are urged to exercise the greatest care in the handling of their fruit. No sounder advice has been given in these notes than that dealing with the gathering, handling, grading, packing, and marketing, not only of citrus, but of all other classes of fruit.

It is equally as important to know how to dispose of fruit to the best advantage as it is to know how to grow it. To say the least, it is very bad business to go to the expense of planting and caring for an orchard until it becomes productive and then neglect to take the necessary care in the marketing of the resultant crop. Main crop lemons should be cut and cured now, instead of being allowed to remain on the tree to develop thick skins and coarseness. As soon as the fruit shows the first signs of colour or is large enough to cure down to about from 2¼ to 2½ in. in diameter, it should be picked, care being taken to handle it very gently, as the secret of successfully curing and keeping this fruit is to see that the skin is not injured in the slightest, as even very slight injuries induce decay or specking. All citrus fruits must be sweated for at least seven days before being sent to the Southern States, as this permits of the majority of specky or fly-infested fruits being rejected. Citrus trees may be planted during this month, provided the land has been properly prepared and is in a fit state to receive them; if not, it is better to delay the planting till the land is right.

In planting, always see that the ground immediately below the base of the tree is well broken up, so that the main roots can penetrate deeply into the soil and not run on the surface. If this is done and the trees are planted so that the roots are given a downward tendency, and all roots tending to grow on or near the surface are removed, the tree will have a much better hold of the soil and, owing to the absence of purely surface roots, the land can be kept well and deeply cultivated, and be thus able to retain an adequate supply of moisture in dry periods. Do not forget to prune well back when planting, or to cut away all broken roots.

All orchards, pineapple and banana plantations should be kept clean and free from all weed growth, and the soil should be well worked so as to retain moisture.

Custard apples will be coming forward in quantity, and the greatest care should be taken to see that they are properly graded and packed for the Southern markets, only one layer of one sized fruit being packed in the special cases provided for this fruit—cases which permit of the packing of fruit ranging from 4 to 6 in. in diameter in a single layer.

Slowly acting manures—such as meatworks manures—may be applied to orchards and vineyards during the month; and lime can be applied where necessary. Land intended for planting with pineapples or bananas during the coming spring can be got ready now, as, in the case of pineapples, it is a good plan to allow the land to lie fallow and sweeten for some time before planting; and, in the case of bananas, scrub fallen now gets a good chance of drying thoroughly before it is fired in spring, a good burn being thus secured.

## THE GRANITE BELT, SOUTHERN AND CENTRAL TABLELANDS.

Clean up all orchards and vineyards, destroy all weeds and rubbish likely to harbour fruit pests of any kind, and keep the surface of the soil well stirred, so as to give birds and predaceous insects every chance to destroy any fruit fly pupæ which may be harbouring in the soil. If this is done, many pests that would otherwise find shelter and thus be able to live through the winter will be exposed to both natural enemies and cold.

Further, it is a good plan to clean up the land before pruning takes place as, if delayed till the pruning has been finished, the land is apt to dry out in a droughty season.

Pruning can be started on such varieties as have shed their leaves towards the end of the month, as it is a good plan to get this work through as early in the season as possible, instead of putting it off until spring. Early-pruned trees develop their buds better than those pruned late in the season. These remarks refer to trees—*not vines*, as the later vines are pruned in the season the better in the Granite Belt District, as late pruned vines stand a better chance to escape injury by late spring frosts.

All worthless, badly diseased, or worn-out trees that are no longer profitable, and which are not worth working over, should be taken out now and burnt, as they are only a menace and a harbour for pests.

Land intended for planting should be got ready as soon as possible, as, if ploughed up roughly and allowed to remain exposed to the winter frosts, it will become sweetened and the trees planted in it will come away much better than if set out in raw land. In any case the land must be properly prepared, for once the trees are planted it is a difficult matter to get the whole of the land as well worked as is possible prior to planting.

Slowly acting manures—such as ground island phosphates or basic phosphates—may be applied to orchards and vineyards. They are not easily washed out of the soil, and will become slowly available and thus ready for the use of the trees or vines during their spring growth. Lime may also be applied where necessary.

This is a good time to attend to any drains—surface, cut-off, or underground. The two former should be cleaned out, and in the case of the latter all outlets should be examined to see that they are quite clear and that there is a good getaway for the drainage water. New drains may also be put in where required.

In the warmer parts citrus fruits will be ready for marketing, and lemons ready for cutting and curing. The same advice that has been given with respect to coast-grown fruit applies equally to that grown inland; and growers will find that careful handling of the fruit will pay them well. Lemons grown inland are, as a rule, of superior quality to those grown on the coast, but are apt to become too large if left too long on the trees, so it is advisable to cut and cure them as soon as they are ready. If this is done and they are properly handled, they may be kept for months, and will be equal to any that are imported.

If the weather is very dry, citrus trees may require an irrigation, but, unless the trees are showing signs of distress, it is better to depend on the cultivation of the soil to retain the necessary moisture, as the application of water now is apt to cause the fruit to become soft and puffy, so that it will not keep or carry well.

Land intended for new orchards should be got ready at once, as it is advisable to plant fairly early in the season in order that the trees may become established before the weather again becomes hot and dry. If the ground is dry at the time of planting, set the trees in the usual manner and cover the roots with a little soil; then give them a good soaking; and when the water has soaked into the soil, fill the hole with dry soil. This is much better than surface watering.

# ASTRONOMICAL DATA FOR QUEENSLAND.

TIMES COMPUTED BY D. EGLINTON, F.R.A.S.

## TIMES OF SUNRISE AND SUNSET.

AT WARWICK.

| 1924. | APRIL. | | MAY. | | JUNE. | |
|---|---|---|---|---|---|---|
| Date. | Rises. | Sets. | Rises. | Sets. | Rises. | Sets. |
| 1 | 6·4 | 5·48 | 6·20 | 5·18 | 6·57 | 5·2 |
| 2 | 6·4 | 5·47 | 6 21 | 5·17 | 6 38 | 5·2 |
| 3 | 6 5 | 5·46 | 6·21 | 5·16 | 6 38 | 5·2 |
| 4 | 6·5 | 5·45 | 6 22 | 5·15 | 6·39 | 5 1 |
| 5 | 6 6 | 5·44 | 6 22 | 5·11 | 6·39 | 5·1 |
| 6 | 6 6 | 5·43 | 6·23 | 5·13 | 6·40 | 5·1 |
| 7 | 6·7 | 5·42 | 6 23 | 5·13 | 6·40 | 5·1 |
| 8 | 6 7 | 5 41 | 6 24 | 5·12 | 6·41 | 5·1 |
| 9 | 6 8 | 5·40 | 6·24 | 5 12 | 6·41 | 5·1 |
| 10 | 6·8 | 5·39 | 6 25 | 5·11 | 6·41 | 5·1 |
| 11 | 6 9 | 5·37 | 6 26 | 5·11 | 6 42 | 5 1 |
| 12 | 6 9 | 5·36 | 6 26 | 5·10 | 6·42 | 5 1 |
| 13 | 6·10 | 5·35 | 6 27 | 5·10 | 6·42 | 5·1 |
| 14 | 6·10 | 5·34 | 6·27 | 5·9 | 6·42 | 5 2 |
| 15 | 6·11 | 5 32 | 6·28 | 5·8 | 6·43 | 5·2 |
| 16 | 6·11 | 5 31 | 6·29 | 5·8 | 6·43 | 5·2 |
| 17 | 6 12 | 5 30 | 6·29 | 5·7 | 6·43 | 5·2 |
| 18 | 6·12 | 5·29 | 6·30 | 5·7 | 6·43 | 5·2 |
| 19 | 6·13 | 5·28 | 6·30 | 5·6 | 6·44 | 5 2 |
| 20 | 6·14 | 5·27 | 6·31 | 5·6 | 6·44 | 5·2 |
| 21 | 6·14 | 5·26 | 6 31 | 5·5 | 6 44 | 5 2 |
| 22 | 6·15 | 5 25 | 6·32 | 5·5 | 6·44 | 5 3 |
| 23 | 6·15 | 5·24 | 6·32 | 5·4 | 6·44 | 5 3 |
| 24 | 6·16 | 5 23 | 6·33 | 5·4 | 6·45 | 5·3 |
| 25 | 6 17 | 5·22 | 6·34 | 5·4 | 6·45 | 5·4 |
| 26 | 6·17 | 5 21 | 6·34 | 5·3 | 6·45 | 5 4 |
| 27 | 6·18 | 5·21 | 6·35 | 5·3 | 6 45 | 5·4 |
| 28 | 6·18 | 5 20 | 6 35 | 5·3 | 6·45 | 5·5 |
| 29 | 6·19 | 5·20 | 6·36 | 5·3 | 6·45 | 5·5 |
| 30 | 6·20 | 5·19 | 6·36 | 5 2 | 6·46 | 5·6 |
| 31 | ... | ... | 6·37 | 5·2 | ... | ... |

## Phases of the Moon, Occultations, &c.

The times stated are for Queensland, New South Wales, Victoria, and Tasmania, when "Summer" Time is not used.

| | | | | |
|---|---|---|---|---|
| 4 | Apr. | ● | New Moon | 5 17 p.m. |
| 12 | ,, | ☾ | First Quarter | 9 12 p.m. |
| 20 | ,, | ○ | Full Moon | 12 10 a.m. |
| 26 | ,, | ☽ | Last Quarter | 2 28 p.m. |

Apogee 9th April, 1·12 a.m.
Perigee 21st April, 6·18 a.m.

On 8th April, between 2 and 3 p.m., the planet Venus will be very near the moon, on its left hand side. The moon will occult it by passing between the earth and the planet before 4 p.m. This should be an interesting spectacle, especially to those who have a telescope or binoculars; even without, the planet should be visible.

On 14th April, the moon will occult Regulus, the brightest star of Leo, between 6 and 7 p.m. The emergence of the planet soon after seven may be observed with binoculars.

The occultation of Uranus on the 29th, about 2 p.m., will be only visible in a telescope.

| | | | | |
|---|---|---|---|---|
| 4 | May | ● | New Moon | 9 0 a.m. |
| 12 | ,, | ☾ | First Quarter | 12 13 p.m. |
| 19 | ,, | ○ | Full Moon | 7 52 a.m. |
| 26 | ,, | ☽ | Last Quarter | 12 16 a.m. |

Apogee 6th May, 12·0 noon.
Perigee 19th May, 3·18 p.m.

Regulus will again be occulted by the moon about 3 o'clock in the morning of the 13th of May.

The great astronomical event of May is the transit of Mercury, on the 8th, when the planet passing between the earth and the sun, will cross the sun's face from right to left, but in an upward direction. The commencement of the transit will be at 7·47 a.m. when the planet will reach the lower edge of the sun's disc. It's slow progress will continue until 3·35 p.m. when the sun's opposite limit will be considerably inclined over to the west.

Great care must be taken when attempting to look at the sun that the eyes are protected *very* carefully by *very* dark-coloured or smoked glass.

| | | | | |
|---|---|---|---|---|
| 3 | June | ● | New Moon | 12 33 a.m. |
| 10 | ,, | ☾ | First Quarter | 11 36 p.m. |
| 17 | ,, | ○ | Full Moon | 2 41 p.m. |
| 24 | ,, | ☽ | Last Quarter | 12 16 p.m. |

Apogee 2nd June, 3·24 p.m.
Also Apogee 29th June, 9·24 p.m.
Perigee 17th June, 1·6 p.m.

The planet Mercury will be a morning star in June being at its greatest distance, west of the sun, on the 4th.

After Mercury being a morning star, Jupiter will be an evening star, rising, in the early part of the month, somewhere about the time of sunset.

Saturn being in conjunction with the moon on 12th of June, will appear about 2 p.m. on the left of the moon, but somewhat higher during the evening hours.

On 16th June, Mercury will be above the moon, distant about eight times its diameter, about 7 p.m.

On 22nd June, The Solstice, the sun, when having reached its furthest northern point in the sky, appears to stand still before turning southwards.

Saturn, on 30th June, will appear stationary, after which it will appear to be moving again east in its normal direction.

For places west of Warwick and nearly in the same latitude, 28 degrees 12 minutes S., add 4 minutes for each degree of longitude. For example, at Inglewood, add 4 minutes to the times given above for Warwick; at Goondiwindi, add 8 minutes; at St. George, 14 minutes; at Cunnamulla, 25 minutes; at Thargomindah, 33 minutes; and at Oontoo, 43 minutes.

The moonlight nights for each month can best be ascertained by noticing the dates when the moon will be in the first quarter and when full. In the latter case the moon will rise somewhat about the time the sun sets, and the moonlight then extends all through the night; when at the first quarter the moon rises somewhere about six hours before the sun sets, and it is moonlight only till about midnight. After full moon it will be later each evening before it rises, and when in the last quarter it will not generally rise till after midnight.

It must be remembered that the times referred to are only roughly approximate, as the relative positions of the sun and moon vary considerably.

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